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An epitome

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(57) [Abstract]
[Technical problem] Detect correctly the "on" period of the alternating voltage by which phase control was carried out, and offer the discharge lamp lighting device which realizes stable dimming actuation.
[Means for Solution] The AC/DC transducer 5 which changes into a direct current alternating voltage by which phase control was carried out with a dimmer 2, The DC/AC transducer 6 which changes an output of said AC/DC transducer 5 into a RF, is impressed by discharge lamp, and carries out the intermittent drive of the discharge lamp, Generate a dimming command signal which carries out the intermittent drive of said DC/AC transducer 6, and it has the dimming control section 7 which outputs said dimming command signal to the DC/AC transducer 6 through a photo coupler 9. And said turn-on of voltage by which phase control was carried out and timing of a turn-off, and ON of a drive of said DC/AC transducer 6 and timing with OFF are synchronized, respectively.

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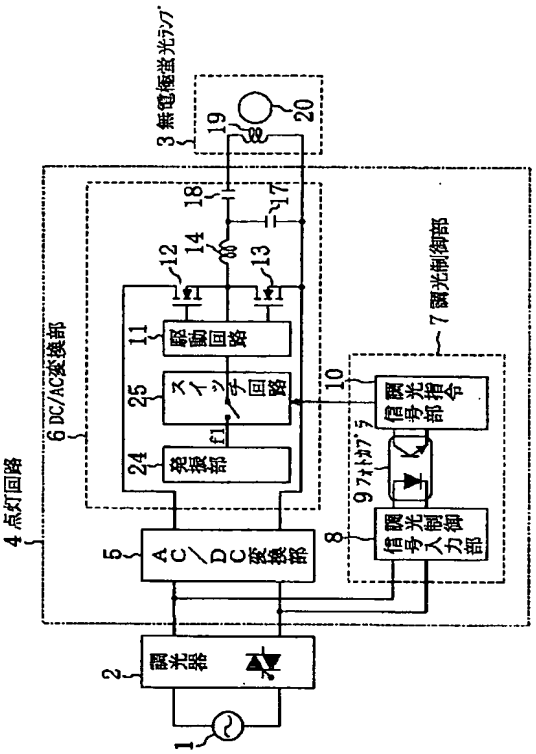

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CLAIMS

[Claim(s)]
[Claim 1] It is the electrodeless discharge lamp lighting device which it is the electrodeless discharge lamp lighting device characterized by providing the following, and said dimming control section detects [lighting device] said turn-on and turn-off of alternating voltage by which phase control was carried out, and synchronizes substantially timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer, respectively. An electrodeless discharge lamp An AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage A DC/AC transducer which carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which said direct current voltage is changed [period] into high-frequency voltage, and makes said electrodeless discharge lamp turn on with the high-frequency voltage concerned, and a putting-out-lights period which switches off said electrodeless discharge lamp A dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC / AC transducer
[Claim 2] Said DC/AC transducer is an electrodeless discharge lamp lighting device according to claim 1 which carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which makes said

electrodeless discharge lamp impress and turn on said high-frequency voltage, and a putting-out-lights period which suspends generating of said high-frequency voltage and switches off said electrodeless discharge lamp.
[Claim 3] Said DC/AC transducer is an electrodeless discharge lamp lighting device according to claim 1 which is with a lighting period which changes said direct current voltage into high-frequency voltage which said electrodeless discharge lamp turns on, and is impressed to said electrodeless discharge lamp, and a putting-out-lights period which changes said direct current voltage into high-frequency voltage which said electrodeless discharge lamp does not turn on, and is impressed to said electrodeless discharge lamp, and carries out the intermittent drive of said electrodeless discharge lamp.
[Claim 4] Said DC/AC transducer is an electrodeless discharge lamp lighting device according to claim 1 which carries out the intermittent drive of said electrodeless discharge lamp in a putting-out-lights period which passes current fewer than said lighting period to a lighting period which makes said electrodeless discharge lamp turn on, and said electrodeless discharge lamp, and is switched off to them by changing voltage between the gate sources of said switching element, when it has at least one switching element, said direct current voltage is changed into high-frequency voltage and it is impressed by said electrodeless discharge lamp.
[Claim 5] Said dimming control section is an electrodeless discharge lamp lighting device according to claim 1 equipped with a photo coupler as a means to transmit said dimming command signal to said DC/AC transducer.

[Claim 6] A non-electrode fluorescent lamp and a lighting circuit which impresses high-frequency voltage to said non-electrode fluorescent lamp, It has a mouthpiece electrically connected to said lighting circuit, and said non-electrode fluorescent lamp, said lighting circuit, and said mouthpiece are assembled by one. Said lighting circuit Said direct current voltage is changed into high-frequency voltage with an AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage. With the high-frequency voltage concerned DC / AC transducer which carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which makes said electrodeless discharge lamp turn on, and a putting-out-lights period which switches off said electrodeless discharge lamp, A dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period is included in said DC/AC transducer. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected. Timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, An electric bulb form radio pole fluorescent lamp which synchronizes substantially timing of said turn-off and putting out lights of an intermittent drive of said DC / AC transducer, respectively.
[Claim 7] Said dimming control section is an electric bulb form radio pole fluorescent lamp [equipped with a dimming signal input part which inputs alternating voltage by which phase control was carried out with said dimmer, a photo coupler connected to the dimming signal input part concerned, and the dimming command signal section which transmits said dimming command signal from the photo coupler concerned to said DC/AC transducer] according to claim 6.
[Claim 8] It is the discharge lamp lighting device which is a discharge lamp lighting device characterized by providing the following, and said dimming control section detects said turn-on and turn-off of alternating voltage by which phase control was carried out, and maintains uniformly the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer. A discharge lamp An AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage A lighting period which said direct current voltage is changed [period] into high-frequency voltage, and makes said discharge lamp impress and turn on the high-frequency voltage concerned A DC/AC transducer which carries out the intermittent drive of said discharge lamp in a putting-out-lights period which suspends generating of said high-frequency voltage and switches off said discharge lamp, and a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC/AC transducer
[Claim 9] It is the discharge lamp lighting device which is a discharge lamp lighting device characterized by providing the following, and said dimming control section detects said turn-on and turn-off of alternating voltage by which phase control was carried out, and maintains uniformly the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer. A discharge lamp An AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct

current voltage A lighting period which changes said direct current voltage into high-frequency voltage which said discharge lamp turns on, and is impressed to said discharge lamp A DC/AC transducer which carries out the intermittent drive of said discharge lamp in a putting-out-lights period which changes said direct current voltage into high-frequency voltage which said discharge lamp does not turn on, and is impressed to said discharge lamp, and a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC/AC transducer
[Claim 10] It is the discharge lamp lighting device which is a discharge lamp lighting device characterized by providing the following, and said dimming control section detects said turn-on and turn-off of alternating voltage by which phase control was carried out, and maintains uniformly the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer. A discharge lamp An AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage A DC/AC transducer which carries out the intermittent drive of said discharge lamp in a putting-out-lights period which passes current fewer than said lighting period to a lighting period which makes said discharge lamp turn on by changing voltage between the gate sources of said switching element when it has at least one switching element, said direct current voltage is changed into high-frequency voltage and it is impressed by said discharge lamp, and said discharge lamp, and is switched off to them A dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC / AC transducer
[Claim 11] Said dimming control section is the discharge lamp lighting device of any one publication of ten from claim 8 which detects said turn-on and turn-off of alternating voltage by which phase control was carried out, and maintains substantially said amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer to zero.
[Claim 12] Said dimming control section is the discharge lamp lighting device of any of claims 8-10 which are equipped with a photo coupler as a means to transmit said dimming command signal to said DC/AC transducer, or one publication.
[Claim 13] Said discharge lamp is the discharge lamp lighting device of any of claims 8-10 which are the owner electrode fluorescent lamps which have an electrode, or one publication.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to an electrodeless discharge lamp lighting device, an electric bulb form radio pole fluorescent lamp, and a discharge lamp lighting device. It is related with the lighting device which modulates the light of a lamp especially with the dimmer for incandescent lamps.
[0002]
[Description of the Prior Art] Since effectiveness is high and long lasting compared with an incandescent lamp, the fluorescent lamp has spread through an earth environmental protection list widely from a viewpoint of

economical efficiency. Moreover, it is in the trend through which the handiness which is observed as the energy-saving light source at a residence, a hotel, a restaurant, etc., replaces with an electric bulb, and can be used as it is also has the compact self-ballasted fluorescent lamp with which the fluorescent lamp and the lighting circuit were unified, and it spreads increasingly in recent years.

[0003] Furthermore, a non-electrode compact self-ballasted fluorescent lamp without an electrode attracts attention as the light source with a life several times economical from a ******** compared with the compact self-ballasted fluorescent lamp of the conventional owner electrode, and it is in the orientation which need increases recently.

[0004] On the other hand, in order to consider as the comfortable light environment which is performing various life actions and was doubled with it being as enjoying a happy circle with a family **** [, and] at these life actions, considering as brightness suitable to each field is called for. [that people read a book in a residence or a hotel] In the case of an electric bulb, brightness is easily changeable by using the commercial dimmer for electric bulbs. Dimming of an incandescent lamp has a common method of using the dimmer for electric bulbs, in order to input into an incandescent lamp the method, i.e., the voltage by which phase control was carried out, of changing brightness by turning on / turning off source-power-supply voltage, and changing the "on" period. Although changing brightness on the other hand using the existing dimmer for electric bulbs in the case of a compact self-ballasted fluorescent lamp as well as the case of an electric bulb is called for, since luminescence of a fluorescent lamp is based on discharge, it is difficult for realizing the fluorescent lamp which can modulate the light of the level which can actually be used only by adjusting a supply voltage like an electric bulb (for example, the patent reference 1, 2, and 3 and 4 reference).

[0005]

[Patent reference 1] JP,11-111486,A [the patent reference 2] The patent No. 2831016 official report [the patent reference 3] JP,2-199796,A [the patent reference 4] JP,2000-268992,A [0006]

[Problem(s) to be Solved by the Invention] In response to the needs of the user who wants to change brightness like the case of an electric bulb recently using the existing dimmer for electric bulbs, it connected with the dimmer for electric bulbs, and the compact self-ballasted fluorescent lamp of the owner electrode which can carry out dimming lighting was developed (patent reference 1). However, the actual condition is that that whose light can be modulated with the compact self-ballasted fluorescent lamp of a non-electrode is not yet developed.

[0007] Moreover, when carrying out dimming lighting of the fluorescent lamp of said owner electrode whose light can be modulated, this fluorescent lamp is connected and used for the commercial dimmer for electric bulbs in many cases. In this case, although the light must have been able to been theoretically modulated even if it used which dimmer for electric bulbs as a commercial dimmer for electric bulbs, depending on the dimmer for electric bulbs, dimming lighting of the lamp could not be carried out normally, but invention-in-this-application persons found out by actual trial that the fault of producing CHIRATSUKI or being hard to turn on a fluorescent lamp might arise.

[0008] This invention aims at offering the electrodeless discharge lamp lighting device, electric bulb form radio pole fluorescent lamp, and discharge lamp lighting device for solving the technical problem mentioned above which it is, prevent the difficulty of carrying out of CHIRATSUKI or lighting, and realize stable dimming actuation.

[0009] Moreover, this invention supplies electrical energy through between the whole term of the "on" period of the voltage by which phase control was carried out, and sets it as other purposes to make a dimming range large more compared with the conventional lighting device by making it turn on a discharge lamp.

[0010]

[Means for Solving the Problem] An electrodeless discharge lamp lighting device concerning this invention changes said direct current voltage into high-frequency voltage with an electrodeless discharge lamp and an AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage. With the high-frequency voltage concerned DC / AC transducer which carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which makes said electrodeless discharge lamp turn on, and a putting-out-lights period which switches off said electrodeless discharge lamp, It is an electrodeless discharge lamp lighting device equipped with a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC / AC transducer. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected, and timing of said turn-on and lighting of an

intermittent drive of said DC/AC transducer and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer are synchronized substantially, respectively.
[0011] In a certain suitable operation gestalt, said DC/AC transducer carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which makes said electrodeless discharge lamp impress and turn on said high-frequency voltage, and a putting-out-lights period which suspends generating of said high-frequency voltage and switches off said electrodeless discharge lamp.
[0012] Moreover, in a certain suitable operation gestalt, said DC / AC transducer are with a lighting period which changes said direct current voltage into high-frequency voltage which said electrodeless discharge lamp turns on, and is impressed to said electrodeless discharge lamp, and a putting-out-lights period which changes said direct current voltage into high-frequency voltage which said electrodeless discharge lamp does not turn on, and is impressed to said electrodeless discharge lamp, and carries out the intermittent drive of said electrodeless discharge lamp.
[0013] Furthermore, in another suitable operation gestalt, said DC/AC transducer has at least one switching element, and when said direct current voltage is changed into high-frequency voltage and it is impressed by said electrodeless discharge lamp, it carries out the intermittent drive of said electrodeless discharge lamp by changing voltage between the gate sources of said switching element in a putting-out-lights period which passes current fewer than said lighting period to a lighting period which makes said electrodeless discharge lamp turn on, and said electrodeless discharge lamp, and is switched off to them.
[0014] Moreover, as for said dimming control section, it is desirable to have a photo coupler as a means to transmit said dimming command signal to said DC/AC transducer.
[0015] A lighting circuit where an electric bulb form radio pole fluorescent lamp concerning this invention impresses high-frequency voltage to a non-electrode fluorescent lamp and said non-electrode fluorescent lamp, It has a mouthpiece electrically connected to said lighting circuit, and said non-electrode fluorescent lamp, said lighting circuit, and said mouthpiece are assembled by one. Said lighting circuit Said direct current voltage is changed into high-frequency voltage with an AC/DC transducer which changes and outputs with a dimmer alternating voltage by which phase control was carried out to direct current voltage. With the high-frequency voltage concerned DC / AC transducer which carries out the intermittent drive of said electrodeless discharge lamp in a lighting period which makes said electrodeless discharge lamp turn on, and a putting-out-lights period which switches off said electrodeless discharge lamp, A dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period is included in said DC/AC transducer. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected, and timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer are synchronized substantially, respectively.
[0016] As for said dimming control section, it is [said dimming control section] desirable to have a dimming signal input part which inputs alternating voltage by which phase control was carried out with said dimmer, a photo coupler connected to the dimming signal input part concerned, and the dimming command signal section which transmits said dimming command signal from the photo coupler concerned to said DC/AC transducer.
[0017] An AC/DC transducer which the 1st discharge lamp lighting device concerning this invention changes into direct current voltage alternating voltage by which phase control was carried out to a discharge lamp with a dimmer, and is outputted, A lighting period which said direct current voltage is changed [period] into high-frequency voltage, and makes said discharge lamp impress and turn on the high-frequency voltage concerned, A DC/AC transducer which carries out the intermittent drive of said discharge lamp in a putting-out-lights period which suspends generating of said high-frequency voltage and switches off said discharge lamp, It is a discharge lamp lighting device equipped with a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC / AC transducer. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected, and the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer is maintained uniformly.
[0018] An AC/DC transducer which the 2nd discharge lamp lighting device concerning this invention changes into direct current voltage alternating voltage by which phase control was carried out to a discharge lamp with a dimmer, and is outputted, In a lighting period which changes said direct current voltage into high-frequency voltage which said discharge lamp turns on, and is impressed to said discharge lamp, and a putting-out-lights

period which changes said direct current voltage into high-frequency voltage which said discharge lamp does not turn on, and is impressed to said discharge lamp Said discharge lamp to a DC/AC transducer which carries out an intermittent drive, and said DC/AC transducer It is a discharge lamp lighting device equipped with a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected, and the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer is maintained uniformly.

[0019] An AC/DC transducer which the 3rd discharge lamp lighting device concerning this invention changes into direct current voltage alternating voltage by which phase control was carried out to a discharge lamp with a dimmer, and is outputted, When it has at least one switching element, said direct current voltage is changed into high-frequency voltage and it is impressed by said discharge lamp, by changing voltage between the gate sources of said switching element DC / AC transducer which carries out the intermittent drive of said discharge lamp in a putting-out-lights period which passes current fewer than said lighting period to a lighting period which makes said discharge lamp turn on, and said discharge lamp, and is switched off to them, It is a discharge lamp lighting device equipped with a dimming control section which outputs a dimming command signal which changes a ratio of a lighting period and a putting-out-lights period into said DC / AC transducer. Said dimming control section Said turn-on and turn-off of alternating voltage by which phase control was carried out are detected, and the amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC/AC transducer and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer is maintained uniformly.

[0020] In a suitable operation gestalt, said dimming control section detects said turn-on and turn-off of alternating voltage by which phase control was carried out, and maintains substantially said amount of gaps of timing of said turn-on and lighting of an intermittent drive of said DC / AC transducer, and timing of said turn-off and putting out lights of an intermittent drive of said DC/AC transducer to zero.

[0021] Moreover, in a suitable operation gestalt, said dimming control section is equipped with a photo coupler as a means to transmit said dimming command signal to said DC/AC transducer.

[0022] Furthermore, in a suitable operation gestalt, said discharge lamp is an owner electrode fluorescent lamp which has an electrode.

[0023]

[Embodiment of the Invention] It precedes giving details explanation about the gestalt of operation of this invention, and the matter examined in advance in this invention is described.

[0024] First, the discharge lamp lighting device of the conventional owner electrode in the patent reference 1 shown in drawing 8 was examined. The frequency change method which changes and modulates the light of the clock frequency of an inverter circuit is used for this discharge lamp lighting device, and it changes the brightness of a fluorescent lamp according to the conduction angle of the voltage by which phase control was carried out inputted, i.e., the "on" period of voltage, ("on" period).

[0025] The discharge lamp lighting device shown in drawing 8 is equipped with the phase control equipment 102 connected to the source power supply 101, the RF generator 103, and the fluorescent lamp 108, and is equipped with a detection means 109 to detect the conduction angle of phase control voltage further, and the photodetection section 110 which detects the optical output of a fluorescent lamp. Moreover, the RF generator 103 consists of the RF inhibition filter 104, a rectifier 105, a smoothing direct-current-voltage transducer 106 that changes into smoothing direct current voltage the voltage by which phase control was carried out, and the inverter section 107 which changes direct-current-ized conversion voltage into a RF. The inverter section 107 consists of oscillation control sections 172 which emit the signal which controls the switching section 171 and the switching section 107. Moreover, the detection means 109 changes the output frequency of the oscillation control section of the inverter section 107 according to the detected conduction angle. The radiant power output from a discharge lamp changes by changing an output frequency. On the other hand, the photodetection section 110 changes the output frequency of the oscillation control section 172 according to the amount of photodetection.

[0026] It is necessary to change the switching frequency (clock frequency) of an inverter quite widely, and to make the drive circuit which drives a switching element into what can answer in a large frequency range by the dimming method by this frequency change method. Furthermore, it is pointed out that the cure against a noise becomes complicated in order to change the switching frequency of an inverter in the large range, and cost

becomes high (patent reference 2).
[0027] Moreover, there is a phase control method which restricts and modulates the light of lamp current by supplying the output which carried out phase control of the alternating current power from a power supply, and carried out full wave rectification further by the triac as the another dimming method to an inverter circuit, and supplying the RF output to a discharge lamp. However, by this phase control method, if the conduction angle of a triac is brought close to pi and dimming is made deep, phenomena, such as going out of a discharge lamp and CHIRATSUKI, will arise. If such a phase control method is used for the discharge lamp lighting device linked to the electrical input through the dimmer for electric bulbs, it will much more become easy to generate going out and CHIRATSUKI of a discharge lamp.
[0028] As a dimming method which cancels going out produced when dimming is made deep in this phase control method, and a CHIRATSUKI phenomenon, switching frequency of an inverter circuit is fixed, the ratio of the ON time amount of a switching element and off time amount is changed, and there is an intermittent drive method whose light is modulated by impressing the high voltage to a discharge lamp intermittently, for example, it is indicated by the patent reference 3 and the patent reference 4.
[0029] However, even if it uses this intermittent drive method, the fault of a lamp flickering depending on the dimmer for electric bulbs, or being hard to switch on the light may arise. Invention-in-this-application persons considered the cause of this fault because energy required for lighting of a discharge lamp is not supplied, when the dimming command signal did not mainly synchronize with the turn-on of the voltage in which phase control was carried out by the triac of the dimmer for electric bulbs, and a turn-off. Here, a synchronization is the dimming command signal, and the turn-on/turn-off being in agreement in time or always generated in fixed gap time amount. If it is in a non-electrode fluorescent lamp especially, the switching element of an inverter circuit is turned on for the electrical energy supplied to this non-electrode fluorescent lamp. Although it turns off, and supply of the big electrical energy in instant is needed when carrying out an intermittent drive, and a switching element is turned on and a non-electrode fluorescent lamp is started Since the magnitude of voltage changed for every starting of a lamp when the dimming command signal did not synchronize with the turn-on/turn-off of voltage by which phase control was carried out, I thought that a lamp will flicker. For this reason, in the non-electrode fluorescent lamp, the timing of the turn-on of the voltage by which phase control was carried out by the triac was correctly detected with the detection means, and it thought of making the switching element of an inverter circuit turn on with the dimming command signal generated based on this synchronizing with the timing of the turn-on of the voltage by which phase control was carried out.
[0030] From the above examination, by constituting the dimming control section which synchronizes substantially the timing of the turn-on/turn-off of phase control voltage, and the timing of the turn-on/turn-off of a dimming command signal, this invention persons did not produce CHIRATSUKI but realized the discharge lamp lighting device which carries out stable dimming actuation.
[0031] Hereafter, the gestalt of operation by this invention is explained, referring to a drawing. In the following drawings, the same reference mark shows the component which has the same function substantially for simplification. In addition, this invention is not limited to the gestalt of the following operations.
[0032] (Gestalt 1 of operation) Drawing 1 shows typically the configuration of the discharge lamp lighting device concerning the gestalt 1 of operation by this invention.
[0033] The discharge lamp lighting device of the gestalt 1 of this operation consists of a non-electrode fluorescent lamp 3, a dimmer 2 which carries out phase control of the voltage of a source power supply 1, and a lighting circuit 4 which carries out lighting control of the non-electrode fluorescent lamp 3 according to the turn-on and turn-off of voltage by which phase control was carried out with said dimmer 2. A source power supply 1 is the AC power supply of 60Hz and 100V, and is connected to the dimmer 2. A dimmer 2 is a dimmer using the phase control of the common knowledge which used the triac, and the commercial dimmer for incandescent lamps can be used for it.
[0034] The lighting circuit 4 consists of an AC/DC transducer 5, DC / AC transducer 6, and a dimming control section 7. In addition, the AC/DC transducer 5 said here, a DC/AC transducer, and the terminological concept which becomes dimming control-section 7 are equivalent to what is expressed in a term called a smoothing direct-current-voltage transducer, the inverter section, and a detection means in the patent reference 1, respectively.
[0035] The AC/DC transducer 5 changes into a direct current the voltage which is supplied from a dimmer 2 and by which phase control was carried out. As this AC/DC transducer, the thing using a diode bridge, the capacitor for smooth, etc. can be used that what is necessary is just to use a well-known thing.

[0036] Moreover, the DC/AC transducer 6 consists of the oscillation section 24, a switching circuit 25, the drive circuit 11, MOSFETs 12 and 13, an inductor 14 for resonance, and capacitors 17 and 18 for resonance. An induction coil 19 is connected to the capacitor 18 for resonance at a serial, and parallel connection of the series circuit of an induction coil 19 and the capacitor 18 for resonance is further carried out to the capacitor 17 for resonance. The non-electrode fluorescent lamp 3 consists of an induction coil 19 and an electrodeless discharge bulb 20.

[0037] Moreover, the dimming control section 7 consists of the dimming control signal input section 8 which inputs the voltage by which phase control was carried out with the dimmer 2, a photo coupler 9, and the dimming command signal section 10 which transmits a dimming command signal to the DC/AC transducer 6.

[0038] The reason using [on this invention and] the photo coupler 9 is for transmitting with sufficient timing to the drive circuit 11 which drives switching elements 12 and 13 certainly, without influencing a dimming command signal of a power circuit, i.e., DC / AC conversion circuit, through a switching circuit 25 according to change of voltage by which phase control was carried out with a dimmer 2. In addition, with the natural thing, the photo coupler of an early high-speed response of build up time and falling time amount is used as a photo coupler 9 for it.

[0039] Hereafter, actuation of the gestalt 1 of this operation is only explained in between.

[0040] The alternating voltage by which phase control of the output voltage of a source power supply 1 was carried out with the dimmer 2, and phase control was carried out with the dimmer 2 is changed into direct current voltage by the AC/DC transducer 5.

[0041] The drive circuit 11 of MOSFETs 12 and 13 of DC / AC transducer 6 drives the direct current voltage graduated by AC / DC transducer 5 with the output of drive frequency [of the oscillation section 24] f1 (Hz) **, and it is changed into high-frequency voltage when MOSFETs 12 and 13 turn on and turn off by turns. This high-frequency voltage is impressed to the resonance circuit which consists of the inductor 14 for resonance, capacitors 17 and 18 for resonance, and an induction coil 19. Here, since the non-electrode fluorescent lamp 3 consists of an induction coil 19 and an electrodeless discharge bulb 20, it can be said that the lighting circuit 4 impresses high-frequency voltage to the non-electrode fluorescent lamp 3. With the energy supplied by the alternating current electromagnetic field generated in the electrodeless discharge bulb 20 according to the current which flows an induction coil 19, the luminescence gas (not shown) enclosed in the electrodeless discharge bulb is excited, and light is emitted. As luminescence gas, these mixed gas, such as mercury, a krypton, and a xenon, is used, for example.

[0042] In addition, the dimming command signal with which the turn-on of voltage and the timing of a turn-off by which phase control was carried out with the dimmer 2 in this case were detected by the dimming control section 7, and were generated in the period during this turn-on and turn-off (namely, "on" period of the voltage by which phase control was carried out), and the dimming control section 7 continues being transmitted to a switching circuit 25. the period (a "off" period or putting-out-lights period of a non-electrode fluorescent lamp) when a switching circuit serves as ON at, the period (a "on" period or lighting period of a non-electrode fluorescent lamp) when the dimming command signal is transmitted to the switching circuit 25 makes the drive circuit 11 of MOSFETs 12 and 13 turn on at, and the dimming command signal is not transmitted to a switching circuit 25 to this -- a switching circuit -- 25 -- it becomes off and the drive circuit 11 of MOSFETs 12 and 13 becomes off. During the period of ON of a switching circuit, MOSFETs 12 and 13 are drive frequencies f1 (Hz), and repeat turning on and off by turns. According to the "on" period of the voltage by which phase control was carried out with the dimmer 2 changing, the ratio of the "on" period of a switching circuit and a "off" period decided with the dimming command signal from the dimming control section 7 changes, and the ratio (it is called a duty ratio) of the "on" period of MOSFETs 12 and 13 and a "off" period changes according to this. The electrical energy input to the non-electrode fluorescent lamp 3 changes by changing this duty ratio, and dimming of the non-electrode fluorescent lamp 3 is performed.

[0043] It explains now somewhat in detail about actuation of the dimming control section 7.

[0044] Hereafter, actuation is explained, referring to drawing 1 and drawing 2 . In four drawings showing the wave from a to d of drawing 2 , a horizontal axis is a time-axis and is a common scale in each drawing.

[0045] a of drawing 2 shows the wave of the voltage by which phase control was carried out with the dimmer 2, and this voltage by which phase control was carried out is first inputted into the dimming control signal input section 8 of the dimming control section 7, and full wave rectification is carried out in this dimming control signal input section 8, it is decompressed on suitable voltage (for example, 2V) to drive a photo coupler 9 further, and is impressed to a photo coupler 9. The voltage which is inputted into a photo coupler 9 and by

which full wave rectification was carried out carries out a turn-on, and the light emitting diode further built in the photo coupler 9 after the build up time (for example, 20 microseconds) of a photo coupler 9 emits light at the same time the voltage by which phase control was carried out with the dimmer 2 carries out a turn-on. From the transistor which constitutes a photo coupler 9 by luminescence of this diode, a dimming command signal is transmitted to a switching circuit 25 through the dimming command signal section 10, and MOSFETs 12 and 13 of the DC/AC transducer 6 drive by drive frequency f1 (Hz) by this. The turn-off of the voltage by which phase control was carried out with the dimmer is carried out, luminescence of a photo coupler 9 falls by this, and the ON state of this dimming command signal is maintained to the time amount from which a dimming command signal will be in an OFF state. If the turn-off of the voltage by which the dimming command signal was turned on through the photo coupler 9, and phase control was further carried out when the turn-on of the voltage by which phase control was carried out with the dimmer was carried out again is carried out, the dimming command signal transmitted to a switching circuit 25 through a photo coupler 9 will be turned off, and the drive of MOSFETs 12 and 13 of the DC/AC transducer 6 will stop.

[0046] Thus, the wave which shows the condition that ON of a dimming command signal and OFF are repeated is shown in b of drawing 2 . MOSFET12 was taken up as an example, the time-axis was carried out to the wave (b of drawing 2) of a dimming command signal in common, and the wave of the drain current of this MOSFET12 was shown in c of drawing 2 so that the relation between the wave (b of drawing 2) of this dimming command signal and the drive of MOSFETs 12 and 13 might be known. It is the same as that of what also showed the drain current of MOSFET13 to c of drawing 2 about MOSFET12. Moreover, the luminescence wave from an electrodeless discharge lamp was shown in d of drawing 2 . By forming the dimming control section 7 using a photo coupler 9, as shown in drawing 2 , it synchronized with the turn-on and turn-off of voltage by which phase control was carried out with the dimmer 2 correctly, the drive of MOSFETs 12 and 13 was turned on and turned off, and it was checked experimentally that the radiant power output from the non-electrode fluorescent lamp 3 in response to this is obtained. In addition, a synchronization here is contemporary [including the delay of a short time by the build up time of a photo coupler 9, falling time amount, etc. / substantial]. Since the delay of such a short time is short compared with the period of input alternating voltage, it is uninfluential to a radiant power output.

[0047] In addition, at the DC/AC transducer 6 in the non-electrode fluorescent lamp of the gestalt 1 of this operation, although MOSFET was used as a switching element, even if it uses a power transistor, it is easy to be natural.

[0048] The frequency of the high-frequency voltage which the lighting circuit 4 impresses to the non-electrode fluorescent lamp 3 here in the electric bulb form radio pole fluorescent lamp of the gestalt of this operation is explained briefly. The frequency concerned in the gestalt of this operation serves as a field with a comparatively low frequency of 1MHz or less (for example, 50-500kHz) compared with 13.56MHz of the ISM band currently generally used practical, or several MHz. It is as follows when the reason for using the frequency of this low frequency field is explained. First, when making it operate in a comparatively high frequency domain like 13.56MHz or several MHz, the noise filter for controlling the line noise generated from the RF power circuit in a lighting circuit (circuit board) will become large-sized, and the volume of a RF power circuit will become large. Moreover, in order to clear the regulation since very severe regulation is prepared in the RF noise by law when the noise emitted or spread from a lamp is a RF noise, it is necessary to use it, preparing an expensive shield, and it becomes a serious failure when aiming at a cost cut. On the other hand, since it becomes possible to use a member with a small size as a member which constitutes a RF power circuit while being able to use the cheap general-purpose article currently used as electronic parts for general electronic equipment in making it operate in a 50kHz - about 1MHz frequency domain, a cost cut and a miniaturization can be attained and an advantage is large. However, the non-electrode fluorescent lamp of the gestalt of this operation may be operated also in the field of frequency, such as not only actuation of 1MHz or less but 13.56MHz or several MHz.

[0049] By using the discharge lamp lighting device of the gestalt 1 of operation, as state above, the fault of CHIRATSUKI and un-switching on the light on by unstable lighting which be stated by the term of the technical problem which be stabilize, can carry out dimming lighting and should solve the non-electrode fluorescent lamp for dimming do not arise by making it synchronize with the turn-on and turn-off of voltage by which phase control be carried out with the dimmer 2, and carrying out the intermittent drive of the DC/AC transducer 6.

[0050] Moreover, the discharge lamp lighting device stated with the gestalt 1 of operation which becomes this invention described above is a lighting device which can carry out the maximum use of the power inputted into

the "on" period ("on" period) of the voltage [call / not only / not only / stable dimming] by which phase control was carried out effectively over this whole period. If it puts in another way, the power days of supply to a discharge lamp will be a lighting device with a wide dimming range by necessarily not synchronizing with the voltage by which phase control was carried out compared with the conventional lighting device for dimming which becomes less than the "on" period of the voltage by which phase control was carried out.

[0051] (Gestalt 2 of operation) The discharge lamp lighting device concerning the gestalt 2 of operation of this invention is similar with the configuration of the gestalt 1 of operation, and, as for the gestalt 1 of operation, the dimming control sections 7 differ.

[0052] The point that the gestalt of this operation differs from the gestalt 1 of operation is a point of starting from the photo coupler 9 of the gestalt 1 of operation to a photo coupler 9, and using the long thing of falling time amount. Therefore, the discharge lamp lighting device of the gestalt of this operation always synchronizes the DC/AC transducer 6 with the turn-on of the voltage by which phase control was carried out, and a turn-off with fixed gap time amount, and carries out an intermittent drive. Fixed gap time amount is the response time of a photo coupler 9, for example, is time amount with the period of input alternating voltage longer than several %.

[0053] Next, actuation and the property of the discharge lamp lighting device of the gestalt of this operation are explained based on drawing 10 .

[0054] In drawing showing the wave from drawing 10 a to d, a horizontal axis is a time-axis and is a common scale in each drawing. a of drawing 10 shows the wave of the voltage by which phase control was carried out with the dimmer 2. The conduction angle of the triac of a dimmer 2 is approaching pi from this drawing, and it turns out that it is in the condition that quite deep dimming is performed.

[0055] b of drawing 10 shows the dimming command signal sent to the DC/AC transducer 6 from the dimming control section 7, when voltage like a of drawing 10 by which phase control was carried out is inputted into the lighting circuit 4. After phase control voltage carries out a turn-on so that it may turn out that a and b of drawing 10 are compared, only time amount deltat is in the dimming command signal from the dimming control section 7, and it is sent to the DC/AC transducer 6.

[0056] The drain current of MOSFET12 which is the switching element of the DC/AC transducer 6 in connection with this becomes as it is shown in c of drawing 10 . Since the drain current of MOSFET13 is also almost the same as that of what is shown by c of drawing 10 , it is not illustrating.

[0057] While the drain current of MOSFETs 12 and 13 is flowing, the non-electrode fluorescent lamp 3 emits light, and the radiant power output is as being shown in d of drawing 10 . Since gap time amount **t is fixed, a radiant power output also always becomes fixed and the non-electrode fluorescent lamp 3 does not flicker.

[0058] However, the drain current of MOSFETs 12 and 13 needs big energy, in order that the non-electrode fluorescent lamp 3 may start, and the big current turned on as shown in c of drawing 10 flows at the moment. The turn-on of a dimming command signal by being behind from the turn-on of phase control voltage only for delta t hours The supply time amount of the high-frequency power with which the standup of the drain current of MOSFETs 12 and 13 is supplied only for delay and its part to the non-electrode fluorescent lamp 3 decreases. Luminescence time amount not only becomes short, but Since the drive of the DC/AC transducer 6 has stopped in the condition that phase control voltage immediately after phase control voltage carries out a turn-on is the highest, compared with the case of zero, the radiant power output of the non-electrode fluorescent lamp 3 declines [gap time amount **t] substantially.

[0059] With the gestalt of this operation, since the amount of gaps of the turn-on of the alternating voltage by which phase control was carried out, a turn-off, and the timing of lighting of an intermittent drive of the DC/AC transducer 6 and putting out lights (time amount **t) is maintained uniformly, a flicker of a discharge lamp can be prevented. Although the gap of this timing uses the response time of a photo coupler 9 with the gestalt of this operation, it shifts using a delay circuit etc. and may establish time amount. Moreover, although, as for the case of time amount somewhat shorter than a round term of alternating voltage, gap time amount **t is observed as the timing of lighting of an intermittent drive of the DC/AC transducer 6 and putting out lights has shifted before the turn-on of the alternating voltage by which phase control was carried out, and the turn-off, a flicker of a discharge lamp is prevented also in this case. In addition, when the fall of a radiant power output is taken into consideration, the smaller one of the amount of gaps is desirable, and it is more desirable that it is zero substantially.

[0060] (Gestalt 3 of operation) Although the discharge lamp lighting device in the gestalt 3 of operation concerning this invention is a discharge lamp lighting device which carries out dimming lighting of the non-

electrode fluorescent lamp and is similar with the configuration previously stated by explanation of the gestalt 1 of operation, they differ in the configuration of the DC/AC transducer 6.
[0061] Drawing 3 shows typically the lighting circuit of the discharge lamp lighting device in the gestalt 3 of operation of this invention. The same configuration as the gestalt 1 of operation omits the explanation which attached the same sign and overlapped.
[0062] In drawing 3 , the DC/AC transducer 6 consists of the oscillation section 244, a switching circuit 255, the drive circuit 11, MOSFETs 12 and 13, an inductor 14 for resonance, and capacitors 17 and 18 for resonance. In addition, the oscillation section A and oscillation frequency of f1 (Hz) consist of the oscillation sections B of f2 (Hz) for oscillation frequency, and the oscillation section 244 is set as frequency lower than frequency f1 for frequency f2. The drive circuit 11 is connected with the oscillation section A when a dimming command signal is outputted to a switching circuit 255 from the dimming command signal section 10, and the drive circuit 11 has composition connected with the oscillation section B, when a dimming command signal is not outputted to the drive circuit 255 from the dimming command signal section 10.
[0063] Actuation of the gestalt 3 of this operation is explained briefly below.
[0064] In the gestalt 3 of this operation, the lighting principle of a discharge lamp is the same as the case of the gestalt 1 of operation, overlaps and is not explained.
[0065] Actuation of the dimming control section 7 to the voltage which is inputted into the dimming control section 7 from a dimmer 2 and by which phase control was carried out also abbreviates the same and detailed explanation to the case of the gestalt 1 of operation fundamentally.
[0066] The ON and the dimming command signal output of OFF which were made binary can be obtained from the voltage which was inputted into the dimming control signal input section 8 and by which phase control was carried out by the method of using a photo coupler 9 as the gestalt 1 of operation described previously.
[0067] When the dimming command signal with which a dimming command signal is transmitted to a switching circuit 255 through the transistor built in the photo coupler 9 is ON, in a switching circuit, the oscillation section A and the drive circuit 11 whose oscillation frequency is f1 (Hz) are connected, and the switching element slack 12 and MOSFETs 13 is the switching frequency f1 (Hz), and is driven by turns. High-frequency voltage occurs by this and the non-electrode fluorescent lamp 3 is turned on.
[0068] When the dimming command signal with which a dimming command signal is not transmitted to a switching circuit 255 on the other hand through the transistor built in the photo coupler 9 is OFF, in a switching circuit 255, the oscillation section B and the drive circuit 11 whose oscillation frequency is f2 (Hz) are connected, and the switching element slack 12 and MOSFETs 13 is the switching frequency f2 (Hz), and is driven by turns. However, the high frequency current which flows the induction coil 19 of the non-electrode fluorescent lamp 3 since the frequency f2 of the oscillation section B (Hz) is low set up in this case compared with the frequency f1 of the oscillation section A (Hz) has few dimming command signals compared with the case where it is ON. Thus, in a setup of the oscillation frequency of the oscillation section 244, when frequency is f2 (Hz), current flows through an induction coil 19, but the non-electrode fluorescent lamp 3 is set up so that the light may not be switched on. It is because only discharge inadequate for luminescence does not arise or discharge produces it inside the discharge bulb 20 on the frequency of f2 (Hz). That is, the voltage of f1 (Hz) is the high-frequency voltage which the non-electrode fluorescent lamp 3 turns on, and the voltage of f2 (Hz) is the high-frequency voltage which the non-electrode fluorescent lamp 3 does not turn on.
[0069] In order to help an understanding of actuation of the gestalt 3 of operation, the voltage waveform of the voltage by which phase control was carried out, the wave of a dimming command signal, the wave of the drain current of MOSFET12, and the wave of the radiant power output from the non-electrode fluorescent lamp 3 were shown in a, b, c, and d of drawing 4 , respectively.
[0070] When c of drawing 2 is compared with c of drawing 4 , like the gestalt 3 of this operation to the lights-out of the non-electrode fluorescent lamp 3 The radiant power output from an electrodeless discharge lamp when the current of the degree which is not turned on is passed (c of drawing 4) and the turn-on of the voltage by which phase control was carried out is carried out It turns out that it has started to the lights-out stated with the gestalt 1 of operation with fewer current compared with the case (c of drawing 2) where current is not passed. Since the luminescence gas ionized in the electrodeless discharge bulb 20 also in lights-out exists, this is that for the energy for making next time turn on the electrodeless discharge bulb 20 to decrease. If the energy for making the light switch on decreases, lighting will become easy and, as a result, a flux of light standup will also become early (the standup of the radiant power output of d of drawing 4 becomes steep compared with d of drawing 2).

[0071] Dimming lighting is possible to the authenticity which synchronized with the voltage by which made deep dimming of the non-electrode fluorescent lamp 3 by considering as the configuration of the gestalt 3 of this operation described above, and phase control was carried out even if the "on" period which MOSFETs 12 and 13 of the DC/AC transducer 6 drive made short ****, i.e., duty ratio, small.
[0072] In addition, with the gestalt of this operation, although the frequency f2 of the oscillation section B (Hz) set up lower than the frequency f1 of the oscillation section A (Hz), the frequency f2 of the oscillation section B (Hz) may set it as this and reverse more highly than the frequency f1 of the oscillation section A (Hz).
[0073] Moreover, with the gestalt 3 of the above-mentioned implementation, the flowing high frequency current made the electrodeless discharge bulb 20 fewer than the high frequency current which flows at a lighting period by changing drive frequency into f1 and f2, respectively in the lighting period and the putting-out-lights period at the putting-out-lights period. changing the voltage between the gate sources of MOSFETs 12 and 13 in a lighting period and a putting-out-lights period like this -- drain current is controlled, and even if it makes it the high frequency current which flows the discharge bulb 20 at a putting-out-lights period become less than the high frequency current which flows at a lighting period, the same effect as the gestalt 3 of operation can be acquired.
[0074] (Gestalt 4 of operation) The gestalt 4 of operation is an electrodeless discharge lamp lighting device concerning other applications of this invention. In addition, the same configuration as the gestalten 1 and 3 of operation attaches the same sign, and omits explanation.
[0075] Drawing 5 is the circuit diagram of the electrodeless discharge lamp lighting device in the gestalt 4 of operation of this invention.
[0076] This electrodeless discharge lamp lighting device consists of lighting circuits 4 which carry out lighting control of said non-electrode fluorescent lamp 3 synchronizing with the period of the turn-on of voltage and turn-off by which phase control was carried out, i.e., an "on" period, with the non-electrode fluorescent lamp 3, the dimmer 2 which carries out phase control of the input voltage, and said dimmer 2.
[0077] Hereafter, the configuration and actuation of an electrodeless discharge lamp lighting device of the gestalt 4 of this operation are explained.
[0078] The lighting circuit 4 consists of an AC/DC transducer 5, DC / AC transducer 6, and a dimming control section 7.
[0079] The AC/DC transducer 5 consists of a diode bridge DB1 and an electrolytic capacitor C2. It is easy to be natural even if the resistance for rush current prevention and a noise prevention filter are connected to this AC / DC transducer 5.
[0080] If a power supply is inputted, the voltage by which phase control was carried out with the dimmer 2 will be rectified in the diode bridge DB1 of the AC/DC transducer 5, it will graduate with an electrolytic capacitor C2 further, and this output will be sent to DC / AC transducer 6.
[0081] Next, in explaining the configuration and actuation of the DC/AC transducer 6, first, a dimming command signal is not sent to DC / AC transducer 6 from the dimming control section 7, namely, a transistor Q4 is off, MOSFETs 12 and 13 which are the switching elements of DC / AC transducer 6 consider the condition of driving, and this condition is explained.
[0082] Inputted into a dimmer 2 from a source power supply 1, it is rectified by the AC/DC transducer 5 and the voltage by which phase control was carried out charges the capacitor C8 which achieves a smoothing capacitor C2, the trigger capacitor C4 of MOSFET13 of the DC/AC transducer 6, and a charge pump circuit function.
[0083] If the charge voltage of the trigger capacitor C4 reaches the CHIENA voltage of the CHIENA diode ZD4, current flows through resistance R2, R4, and R3, and gate voltage will be supplied between the gate sources of MOSFET13, it will obtain, and MOSFET13 will be turned on.
[0084] Since the voltage of a smoothing capacitor C2 is lower than supply voltage, current flows from a power supply 1 through the AC/DC transducer 5 at the beginning when MOSFET13 was turned on through the primary windings CT1 and MOSFET13 of resonant capacitors 18 and 17, an inductor L1, an induction coil 19, and Transformer CT to a dimmer 2 and a pan.
[0085] Since induced voltage, on the other hand, generates the primary winding CT 1 of Transformer CT in the secondary winding CT 3 of Transformer CT according to the flowing current and gate voltage can be supplied to MOSFET13, MOSFET13 continues an ON state.
[0086] However, if the flowing current increases each coil of Transformer CT, the core of Transformer CT itself will carry out magnetic saturation after fixed time amount progress, the induced voltage of the secondary

winding CT 3 of Transformer CT will stop arising, it will become impossible to supply the gate voltage of MOSFET13, and MOSFET13 will become off.
[0087] In addition, since the directions of the current which flows between the gate sources of MOSFET13 connected to the secondary winding CT 2 of Transformer CT and MOSFET12 connected to the secondary winding CT 3 of Transformer CT differ, if MOSFET13 is turned off, the gate voltage of MOSFET12 will rise. Therefore, MOSFET12 will be in an ON state by this power surge.
[0088] If MOSFET12 is turned on, current will flow through the series circuit of the capacitor 18 and induction coil 19 which were connected to MOSFET12, Transformer CT, the inductor L1, the capacitor C17, and the capacitor C17 at juxtaposition. This current resonates with an inductor L1, resonant capacitors C18 and C17, and an induction coil 19.
[0089] Furthermore, if the flowing current increases each coil of the current transformer CT, the core of the current transformer CT itself will carry out magnetic saturation again. When the core of the current transformer CT carries out magnetic saturation, the output of a secondary winding CT 2 is lost and it becomes impossible to supply gate voltage to MOSFET12. In this way, MOSFET12 will be in an OFF state.
[0090] Henceforth, in MOSFET12 and MOSFET13, an ON state and an OFF state can be changed by turns by drive frequency f1 (Hz), 200 [for example,], (kHz) by repeating the actuation mentioned above.
[0091] High-frequency voltage is generated in the resonance circuit of the DC/AC transducer 6 by this, electromagnetic energy is supplied to the electrodeless discharge bulb 20 through an induction coil 19, the luminescence gas enclosed with the interior of the electrodeless discharge bulb 20 is excited, an ultraviolet radiation can be made to be able to emit, excitation luminescence of the fluorescent substance (not shown) applied to the electrodeless discharge bulb 20 interior by this ultraviolet radiation can be carried out, and the non-electrode fluorescent lamp 3 can be turned on.
[0092] Next, a dimming command signal is transmitted to the DC/AC transducer 6 from the dimming control section 7, and actuation in case dimming lighting is performed is explained.
[0093] The voltage (refer to a of drawing 4) by which phase control was carried out with the dimmer 2 is pressured partially so that it may become the suitable voltage for the drive of a photo coupler 9 by resistance R30 and R31, it inputs into diode bridge DB2 and the voltage by which full wave rectification was carried out is impressed to the photodiode of a photo coupler 9. Therefore, the voltage by which full wave rectification was carried out to the photodiode of a photo coupler 9 is impressed at the same time the turn-on of the voltage by which phase control was carried out is carried out, a photodiode emits light, current flows to the photo transistor of a photo coupler 9 by this, and a photo coupler 9 serves as ON.
[0094] If a photo coupler 9 serves as ON, the base potential of a transistor Q4 will become zero, and the collector current of a transistor Q4 will not flow. For this reason, ON of MOSFET12 and MOSFET13 and an OFF drive are not affected at all, but drain current as shown in c of drawing 4 flows to MOSFETs 12 and 13, high-frequency voltage occurs in the DC/AC transducer 6, and the non-electrode fluorescent lamp 3 turns on Q4.
[0095] The turn-off of the voltage by which phase control was carried out is carried out, it continues until voltage is no longer impressed to the photodiode of a photo coupler 9 through diode bridge DB2, namely, lighting of the non-electrode fluorescent lamp 3 maintains the current which the turn-on of the voltage by which phase control was carried out with the dimmer 2 is carried out, and flows through a photo transistor.
[0096] If the turn-off of the voltage by which phase control was carried out with the dimmer 2 is carried out, the voltage impressed to a photo coupler 9 will be zero, therefore a photo coupler 9 will be in an OFF state. In this condition, direct current voltage is impressed to the base of a transistor Q4 by the DC-power-supply circuit (for example, 3 terminal regulator) 40 through resistance R35, and the collector current of Q4 flows. Resistance R38 will go into resistance R3 and juxtaposition by this, the gate voltage of MOSFET13 falls, MOSFET12 will be in an OFF state, and high-frequency voltage stops requiring for the electrodeless discharge bulb 20, and it switches off the non-electrode fluorescent lamp 3. The OFF state of this MOSFET12 continues until the turn-on of the voltage by which phase control was carried out with the dimmer 2 is carried out again.
[0097] Thus, synchronizing with a turn-on and a turn-off being carried out, the non-electrode fluorescent lamp 3 repeats [the voltage by which phase control was carried out / MOSFETs 12 and 13] lighting and putting out lights for ON and OFF synchronizing with a repeat and MOSFETs 12 and 13 turning on and turning off further. In addition, the amount of [inside / DC/AC transducer 6 / resistance R38] connection is [the joining segment of resistance R6 and zener diode ZD3] sufficient in addition to between two zener diodes ZD3 and ZD4. It is because the non-electrode fluorescent lamp 3 repeats ON and OFF even if it is which.

[0098] Therefore, it cannot be overemphasized that the effect stated with the gestalt 3 of previous operation according to the gestalt of this operation and the same effect are acquired.
[0099] (Gestalt 5 of operation) Drawing 6 is the circuit diagram of the discharge lamp lighting device concerning the gestalt 5 of operation. The discharge bulb 200 is an owner electrode, and a different point from the gestalt 1 of the operation described previously is only a point that the configurations of a load resonance circuit differ, in order to turn on the fluorescent lamp 33 of this owner electrode. In addition, the same configuration as the gestalt 1 of operation attaches the same sign, and omits explanation.
[0100] In drawing 6 , LC resonance circuit which consisted of the fluorescent lamp 33, an inductor 14 for resonance, a capacitor 15 for resonance, and a capacitor 16 for resonance-cum-remaining heat between the drain terminal of MOSFET13 and the source terminal is connected.
[0101] The high voltage occurs as resonance voltage to the both ends of the capacitor 16 of LC resonance circuit mentioned above. If the temperature of an electrode rises according to the remaining-heat current to two electrodes in the discharge bulb 200 and it becomes easy to generate a thermoelectron from an electrode, the discharge bulb 200 will start lifting discharge for dielectric breakdown. If the discharge bulb 200 begins discharge, the discharge which restricted the current which flows the discharge bulb 200 by the inductor 14 for resonance, and was stabilized will be maintained.
[0102] The configuration and actuation of the dimming control section 7 of the gestalt 5 of this operation are the same as that of the case of the gestalt 1 of operation. It is clear from explanation of the gestalt 1 of previous operation that dimming lighting can be stabilized and carried out, it overlaps and by considering the configuration of a discharge lamp lighting device as a configuration like drawing 6 does not explain the fluorescent lamp of the common owner electrode whose light can be modulated.
[0103] (Gestalt 6 of operation) Next, the configuration of the discharge lamp lighting device of the gestalt 6 of operation is explained. Drawing 7 takes up the compact self-ballasted fluorescent lamp of a non-electrode as a gestalt 6 of this operation, and shows the configuration typically. In addition, although the discharge lamp lighting device of the gestalt of this operation considered as the compact self-ballasted fluorescent lamp of a non-electrode, it can also be considered as the configuration of the compact self-ballasted fluorescent lamp of an owner electrode.
[0104] The non-electrode fluorescent lamp 3 which consisted of discharge bulbs 20 of the translucency which the non-electrode compact self-ballasted fluorescent lamp shown in drawing 7 has reentrant 20a, and enclosed mercury and rare gas (not shown), for example, an argon, For example, it has the mouthpieces 56, such as E26 mold for incandescent lamps, the circuit board 54 in which wiring of the configuration of a lighting circuit (for example, circuit shown by drawing 6) was formed in, and each passive circuit elements were attached, and the covering 55 which holds the circuit board.
[0105] Generation of the discharge plasma for the mercury excitation enclosed with the interior of the discharge bulb 20 is performed by the energy supplied by the alternating current electromagnetic field generated by the induction coil 19 in a discharge bulb. The induction coil 19 consists of a ferrite magnetic core, 19a, and coil 19b, and is arranged at reentrant 20a which a discharge bulb has.
[0106] Although the non-electrode fluorescent lamp 3, and the circuit board 54 and a mouthpiece 56 are not illustrated, it connects electrically mutually, respectively, power is supplied by thrusting into the socket for incandescent lamps through a mouthpiece 56, and the non-electrode fluorescent lamp 3 turns them on.
[0107] The alternating voltage inputted through a mouthpiece 56 is the alternating voltage by which phase control was carried out with external phase control equipments (for example, dimmer for incandescent lamps etc.).
[0108] Even if a discharge lamp is not a non-electrode fluorescent lamp but a fluorescent lamp of an owner electrode like the gestalt of this operation, it is easy to be natural [a discharge lamp].
[0109] Moreover, although the gestalt of this operation showed the electric bulb form radio pole fluorescent lamp with which the electrodeless discharge lamp 3, the lighting circuit, and the mouthpiece were assembled by one, the gestalt of this operation may be the discharge lamp lighting device (electrodeless discharge lamp lighting device) to which it is not restricted to this but the non-electrode fluorescent lamp 3 and the lighting circuit are separate.
[0110] (Gestalt of other operations) As long as general lighting, such as a straight pipe, a round pipe, and a U tube, is presented with the configuration of the discharge lamp stated with the gestalten 1-6 of operation, it may be the thing of what kind of configuration.
[0111] Moreover, without being limited to the fluorescent lamp for general lighting, even if the discharge lamp

lighting device of this invention turns on the lamp for vegetable training which has an action spectrum effective in the health line lamp, the vegetable photosynthesis, and morphogenesis which have an action spectrum effective in generation of the erythema effect or vitamin D, for example, it is easy to be natural [a lighting device].

[0112] The discharge lamp which the discharge lamp lighting device of this invention furthermore makes applicable to lighting may be a discharge lamp which does not apply a fluorescent substance to a discharge bulb like a germicidal lamp.

[0113] In addition, although the dimming control section 7 has the configuration which outputs the signal which synchronizes the timing of a turn-on and lighting of an intermittent drive of the DC/AC transducer 6 with the gestalt 1 of the above-mentioned implementation, this is because the synchronized direction can perform dimming actuation good.

[0114] The configuration shown in drawing 9 does not have the intention of synchronizing the timing of a turn-on and lighting of an intermittent drive of the DC/AC transducer 6, though it is lighting circuit 4' of an intermittent drive. The configuration of dimming control-section 7' which is made to generate a dimming control signal and sends a dimming command signal to the DC/AC transducer (inverter circuit) 6 differs from the configuration of the gestalt 1 of the above-mentioned implementation.

[0115] Dimming control-section 7' consists of a dimming signal generator 74 and the dimming command signal section 10 which sends a dimming command signal to DC / AC transducer 6. Half-wave rectification of the output from a dimmer 2 by which phase control was carried out by the triac is carried out through a half wave rectifier circuit 71, the output voltage (120Hz) and the output voltage of the triangular wave generating circuit 72 which generates the reference voltage of reference frequency (120Hz) are compared by the comparator 73, a comparator 73 to frequency is fixed and a square wave-like dimming signal is outputted. The ON time amount and off time amount of delivery and the DC/AC transducer 6 were changed into the DC/AC transducer 6 for this dimming signal through the dimming command signal section 10, and dimming of the non-electrode fluorescent lamp 3 was performed. Using the non-electrode fluorescent lamp 3 as a discharge lamp, switching frequency f1 of an inverter circuit was set to 200kHz, and used MOSFETs 12 and 13 as a switching element.

[0116] An example of an experimental result was shown in drawing 11 .

[0117] Hereafter, actuation and the property of the discharge lamp lighting device of drawing 9 are explained based on drawing 11 . In drawing showing the wave from drawing 11 a to d, a horizontal axis is a time-axis and is a common scale in each drawing. a of drawing 11 shows the wave of the voltage by which phase control was carried out with the dimmer 2. The conduction angle of the triac of a dimmer 2 is approaching pi from this drawing, and it turns out that it is in the condition that quite deep dimming is performed.

[0118] b of drawing 11 shows the dimming command signal sent to the DC/AC transducer 6 from the dimming control section 7, when voltage like a of drawing 10 by which phase control was carried out is inputted into lighting circuit 4'. The turn-on of phase control voltage and the turn-on of a dimming command signal have not taken the synchronization so that it may turn out that a and b of drawing 11 are compared. That is, the timing of the turn-on/turn-off of a dimming command signal has shifted from the timing of the turn-on/turn-off of phase control voltage, and, moreover, the shifting time amount deltat is changed by time of day.

[0119] As this dimming command signal shows b of drawing 11 , when it changes, the drain current of MOSFET12 (or 13) changes like c of drawing 11 , as a result, supply of the electrical energy to a radio pole fluorescent lamp decreases, and a radiant power output changes like d of drawing 11 , and produces CHIRATSUKI.

[0120] If still deeper dimming is carried out with the dimmer 2, the high-frequency power which the drain current of MOSOSFET 12 and 13 decreases, consequently is supplied to the non-electrode fluorescent lamp 3 decreases, and will be in the condition near or or the threshold condition of whether to carry out putting out lights to turn on.

[0121] In the condition that the timing of the turn-on of the voltage by which phase control was carried out, and the timing of the turn-on of the dimming signal from dimming control-section 7' synchronize now, the discharge lamp lighting device which can supply the electrical energy which the non-electrode fluorescent lamp 3 can turn on barely to the non-electrode fluorescent lamp 3 is considered. As this equipment is shown in drawing 11 , the light is almost put out so that the turn-on of a dimming command signal may understand the non-electrode fluorescent lamp 3 attached in this lighting device from the explanation mentioned above, when timing with the turn-on of phase control voltage shifts and the length of that gap time amount is changed, and

it will be in the condition of switching on the light occasionally. Moreover, if gap time amount deltat with the timing of the turn-on of phase control voltage and the turn-on of a dimming command signal becomes large when performing deep dimming, the non-electrode fluorescent lamp 3 will be in the condition that the light cannot be switched on at all.

[0122] Each wave of the phase control voltage when incidentally impressing the phase control voltage of deep dimming shown in drawing 10 a and the same voltage to the discharge lamp lighting device of the gestalt 1 of operation, a dimming command signal, the drain current of MOSFET12, and a radiant power output was shown in a, b, c, and d of drawing 12 , respectively. The discharge lamp lighting device (drawing 1) which becomes this invention which synchronized correctly the turn-on of the switching element of a DC/AC transducer and the timing of a turn-off with the turn-on and turn-off of voltage by which phase control was carried out with the dimmer 2 does not have a flicker, and is checking that there are also many radiant power outputs so that d of drawing 11 and d of drawing 12 may be compared and understood.

[0123]

[Effect of the Invention] As explained above, according to the discharge lamp lighting device which becomes this invention, the voltage by which phase control was carried out with the dimmer A non-electrode, Or the turn-on of the voltage by which phase control was carried out when it inputted into the fluorescent lamp of an owner electrode and the light of a fluorescent lamp was modulated and timing of a turn-off, Stable dimming actuation can be realized without carrying out CHIRATSUKI and going out by synchronizing the turn-on of the dimming command signal for carrying out the intermittent drive of the DC/AC transducer, and the timing of a turn-off.

[0124] Furthermore, by using the discharge lamp lighting device of this invention, compared with the conventional lighting device, more electrical energy can be supplied to a discharge lamp, and increase of a discharge lamp radiant power output can be aimed at.

[Translation done.]

* NOTICES *

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is circuitry drawing of the discharge lamp lighting device of the gestalt 1 of the operation in this invention.

[Drawing 2] They are a circuit in the discharge lamp lighting device of the gestalt 1 of operation, and property drawing of a lamp.

[Drawing 3] It is circuitry drawing of the discharge lamp lighting device of the gestalt 3 of the operation which can set this invention.

[Drawing 4] They are a circuit in the discharge lamp lighting device of the gestalt 3 of operation, and property drawing of a lamp.

[Drawing 5] It is the circuit diagram of the discharge lamp lighting device of the gestalt 4 of the operation in this invention.

[Drawing 6] It is circuitry drawing of the discharge lamp lighting device of the gestalt 5 of the operation in this invention.

[Drawing 7] It is the typical cross section of the discharge lamp lighting device of the gestalt 6 of the operation in this invention.

[Drawing 8] It is circuitry drawing of the owner electrode discharge lamp lighting device in the conventional example.
[Drawing 9] It is circuitry drawing of an asynchronous type discharge lamp lighting device.
[Drawing 10] They are a circuit in the discharge lamp lighting device of the gestalt 2 of operation, and property drawing of a lamp.
[Drawing 11] They are a circuit in the discharge lamp lighting device of drawing 9 , and property drawing of a lamp.
[Drawing 12] They are another circuit in the discharge lamp lighting device of the gestalt 1 of operation, and property drawing of a lamp.
[Description of Notations]
1 Power Supply
2 Dimmer
3 Non-Electrode Fluorescent Lamp (Electrodeless Discharge Lamp, Discharge Lamp)
33 Fluorescent Lamp (Discharge Lamp)
4 4' Lighting circuit
5 AC/DC Transducer
6 DC/AC Transducer
7 7' Dimming control section
9 Photo Coupler
11 Drive Circuit
19 Induction Coil
20 Electrodeless Discharge Bulb
24,244 Oscillation section
25,255 Switching circuit
54 Substrate
55 Case
56 Mouthpiece
71 Half Wave Rectifier Circuit
72 Triangular Wave Generating Circuit
73 Comparator
74 Dimming Signal Generator

[Translation done.]

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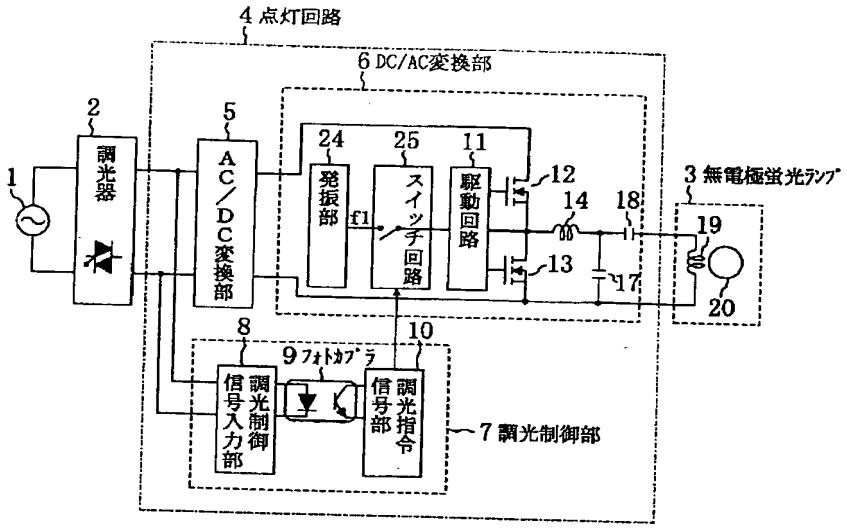
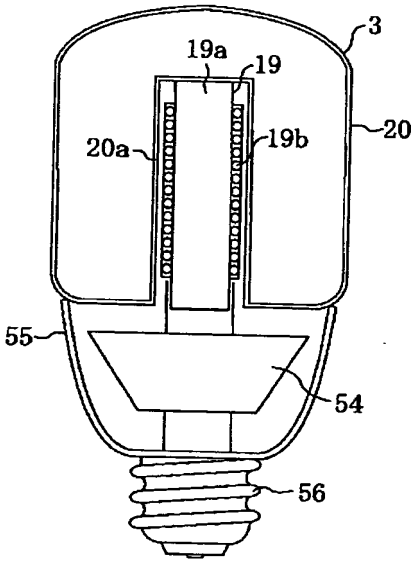
DRAWINGS

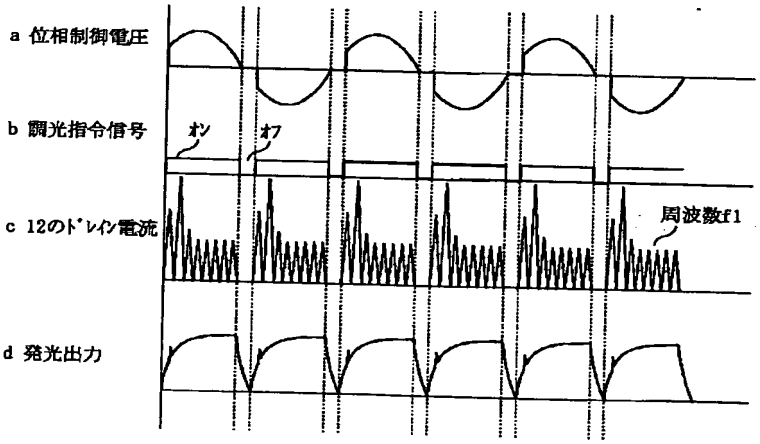
[Drawing 1]



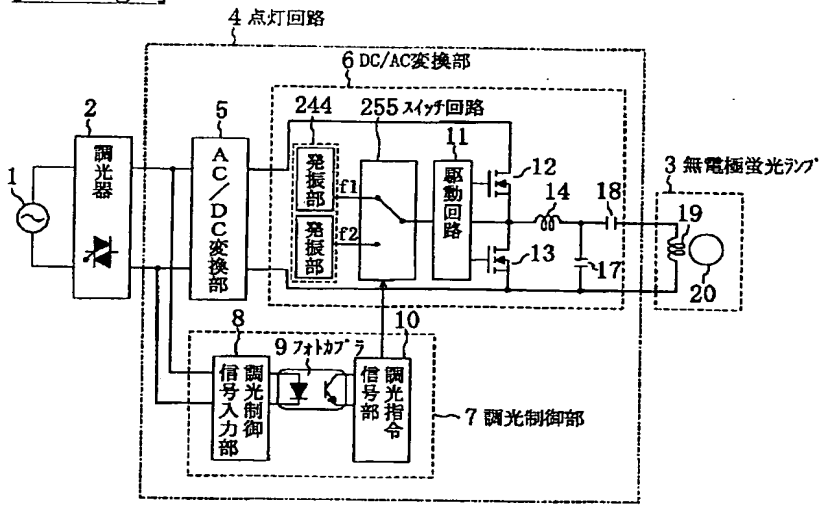
[Drawing 7]



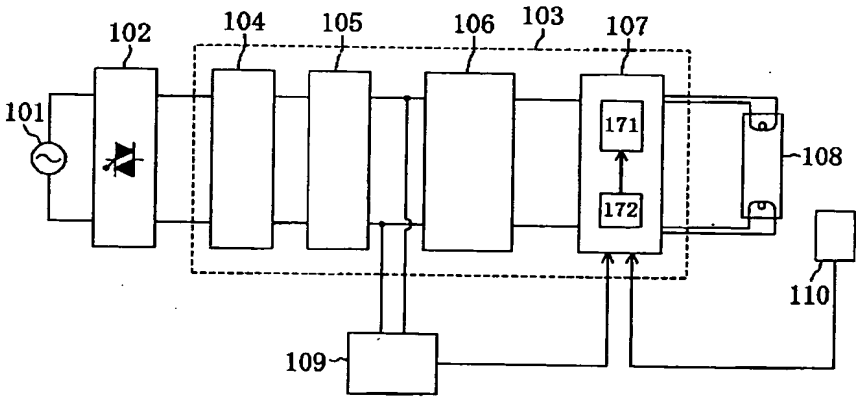
[Drawing 2]



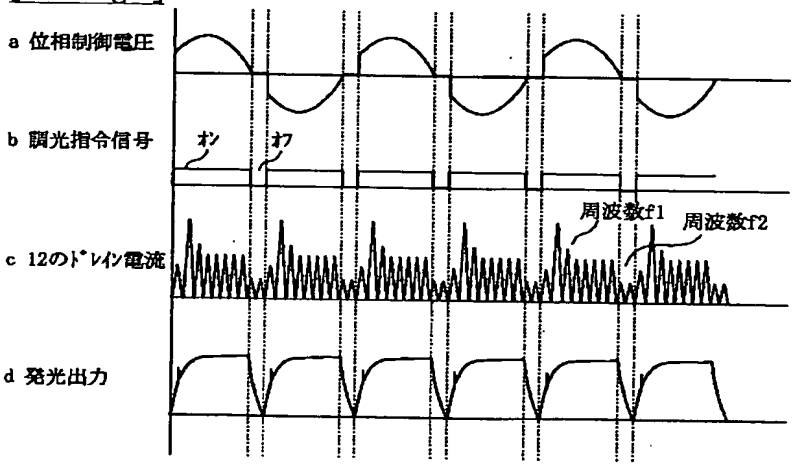
[Drawing 3]



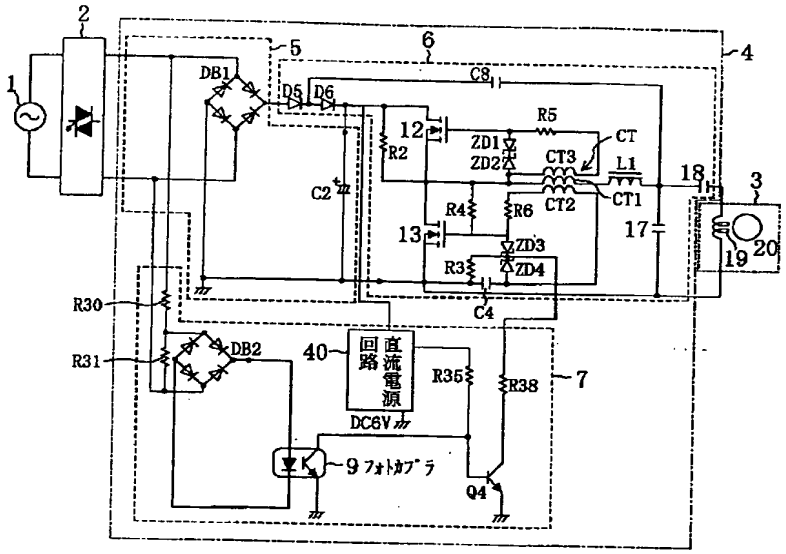
[Drawing 8]



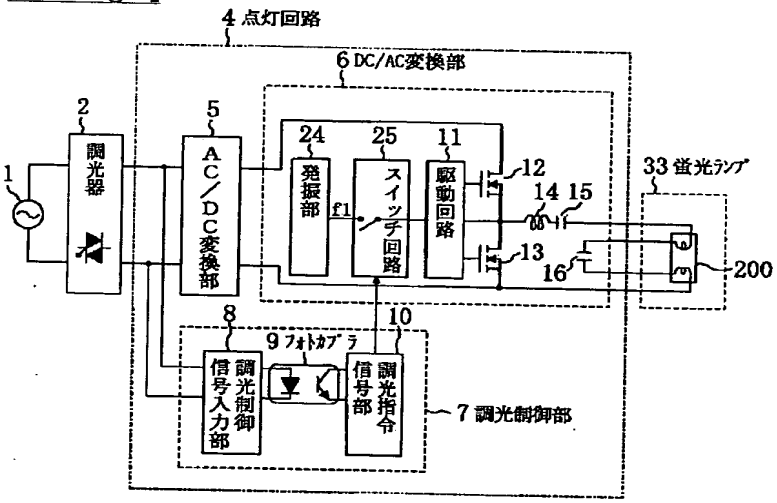
[Drawing 4]



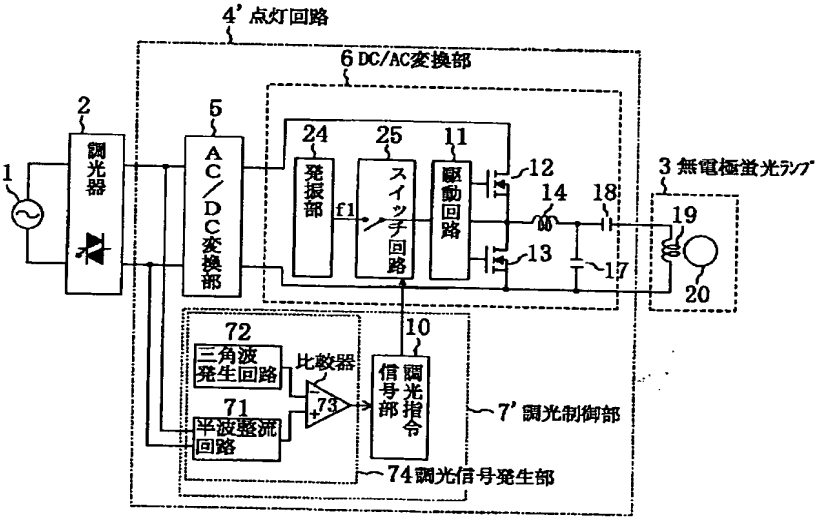
[Drawing 5]



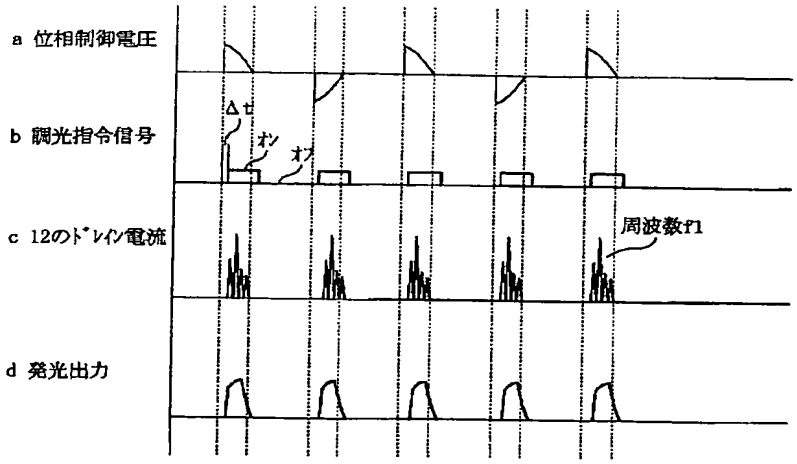
[Drawing 6]



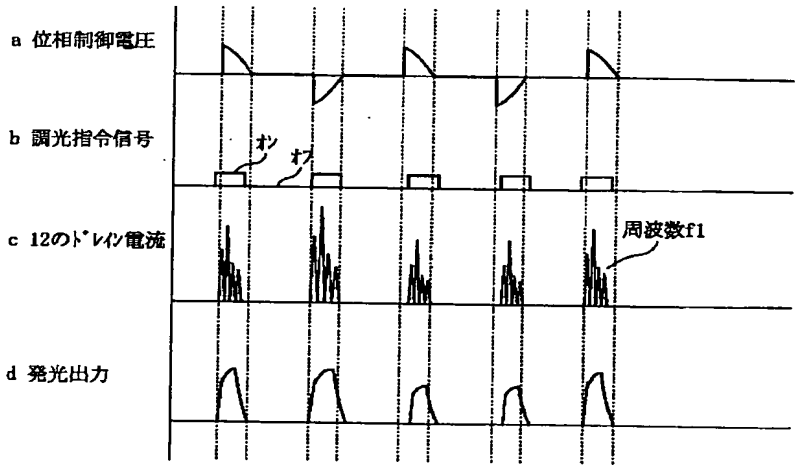
[Drawing 9]



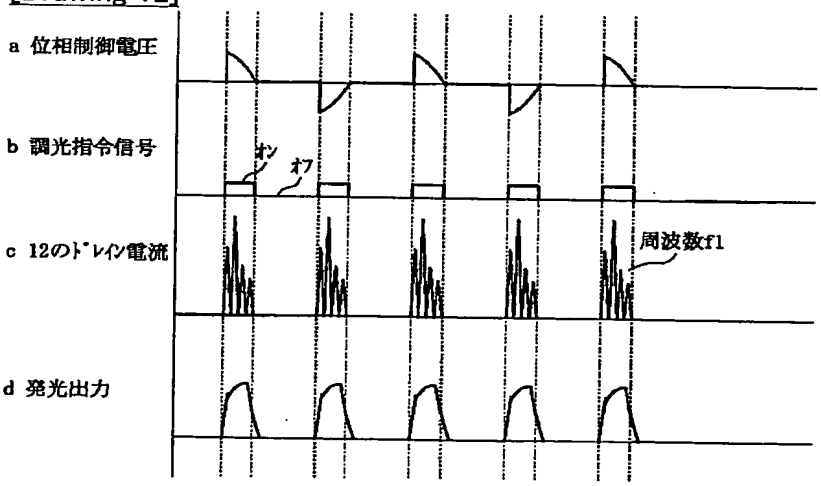
[Drawing 10]



[Drawing 11]



[Drawing 12]



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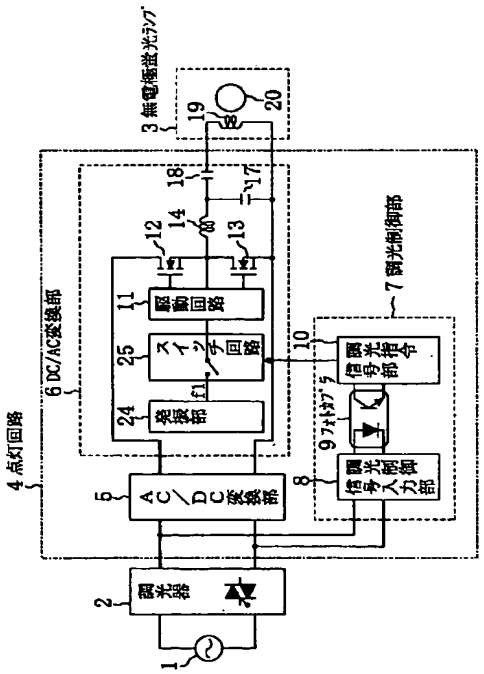
最終頁に続く

(54)【発明の名称】　無電極放電ランプ点灯装置、電球形無電極蛍光ランプおよび放電ランプ点灯装置

(57)【要約】
【課題】　位相制御された交流電圧の導通期間を正確に検出し、安定な調光動作を実現する放電ランプ点灯装置を提供すること。
【解決手段】　調光器２により位相制御された交流電圧を直流に変換するＡＣ／ＤＣ変換部５と、前記ＡＣ／ＤＣ変換部５の出力を高周波に変換し、放電ランプに印加して放電ランプを間欠駆動するＤＣ／ＡＣ変換部６と、前記ＤＣ／ＡＣ変換部６を間欠駆動させる調光指令信号を発生し、前記調光指令信号をフォトカプラ９を介してＤＣ／ＡＣ変換部６に出力する調光制御部７とを有し、且つ、前記位相制御された電圧のターン・オン及びターン・オフのタイミングと、前記ＤＣ／ＡＣ変換部６の駆動のオン及びオフとのタイミングとを、それぞれ、同期させる。



【特許請求の範囲】

【請求項１】　無電極放電ランプと、
調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、
前記直流電圧を高周波電圧に変換し、当該高周波電圧によって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、
前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える無電極放電ランプ点灯装置であって、
前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとを、それぞれ実質的に同期させる、無電極放電ランプ点灯装置。

【請求項２】　前記ＤＣ／ＡＣ変換部は、前記高周波電圧を前記無電極放電ランプに印加して点灯させる点灯期間と、前記高周波電圧の発生を停止して前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動する、請求項１に記載の無電極放電ランプ点灯装置。

【請求項３】　前記ＤＣ／ＡＣ変換部は、前記無電極放電ランプが点灯する高周波電圧に前記直流電圧を変換して前記無電極放電ランプに印加する点灯期間と、前記無電極放電ランプが点灯しない高周波電圧に前記直流電圧を変換して前記無電極放電ランプに印加する消灯期間とで、前記無電極放電ランプを間欠駆動する、請求項１に記載の無電極放電ランプ点灯装置。

【請求項４】　前記ＤＣ／ＡＣ変換部は、少なくとも１つのスイッチング素子を有し、前記直流電圧を高周波電圧に変換して前記無電極放電ランプに印加する場合に、前記スイッチング素子のゲート・ソース間の電圧を変えることによって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプに前記点灯期間よりも少ない電流を流して消灯する消灯期間とで前記無電極放電ランプを間欠駆動する、請求項１に記載の無電極放電ランプ点灯装置。

【請求項５】　前記調光制御部は、前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する手段としてフォトカプラを備える、請求項１に記載の無電極放電ランプ点灯装置。

【請求項６】　無電極蛍光ランプと、
前記無電極蛍光ランプに高周波電圧を印加する点灯回路と、
前記点灯回路に電気的に接続された口金とを備え、
前記無電極蛍光ランプと前記点灯回路と前記口金とは一体に組み立てられており、
前記点灯回路は、
調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、
前記直流電圧を高周波電圧に変換し、当該高周波電圧によって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、
前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを含んでおり、
前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとを、それぞれ実質的に同期させる；電球形無電極蛍光ランプ。

【請求項７】　前記調光制御部は、前記調光器によって位相制御された交流電圧を入力する調光信号入力部と、当該調光信号入力部に接続されたフォトカプラと、当該フォトカプラからの前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する調光指令信号部とを備える、請求項６に記載の電球形無電極蛍光ランプ。

【請求項８】　放電ランプと、
調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、
前記直流電圧を高周波電圧に変換して、当該高周波電圧を前記放電ランプに印加して点灯させる点灯期間と、前記高周波電圧の発生を停止して前記放電ランプを消灯する消灯期間とで前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、
前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、
前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのずれ量を一定に維持する、放電ランプ点灯装置。

【請求項９】　放電ランプと、
調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、
前記放電ランプが点灯する高周波電圧に前記直流電圧を変換して前記放電ランプに印加する点灯期間と、前記放電ランプが点灯しない高周波電圧に前記直流電圧を変換して前記放電ランプに印加する消灯期間とで、前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、
前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、
前記調光制御部は、前記位相制御された交流電圧のター

ン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのずれ量を一定に維持する、放電ランプ点灯装置。

【請求項１０】　放電ランプと、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、

少なくとも１つのスイッチング素子を有し、前記直流電圧を高周波電圧に変換して前記放電ランプに印加する場合に、前記スイッチング素子のゲート・ソース間の電圧を変えることによって、前記放電ランプを点灯させる点灯期間と前記放電ランプに前記点灯期間よりも少ない電流を流して消灯する消灯期間とで前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、

前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、

前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのずれ量を一定に維持する、放電ランプ点灯装置。

【請求項１１】　前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとの前記ずれ量を実質的にゼロに維持する、請求項８から１０のいずれか一つに記載の放電ランプ点灯装置。

【請求項１２】　前記調光制御部は、前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する手段としてフォトカプラを備える、請求項８から１０の何れか一つに記載の放電ランプ点灯装置。

【請求項１３】　前記放電ランプは、電極を有する有電極蛍光ランプである請求項８から１０の何れか一つに記載の放電ランプ点灯装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、無電極放電ランプ点灯装置、電球形無電極蛍光ランプ及び放電ランプ点灯装置に関する。特に白熱電球用調光器でランプを調光する点灯装置に関する。

【０００２】

【従来技術】蛍光ランプは、白熱電球に比べて効率が高く、且つ長寿命であることから地球環境保護並びに経済性の観点から広く普及している。また近年、蛍光ランプと点灯回路とが一体化された電球形蛍光ランプが、住宅、ホテル、レストランなどで省エネルギー光源として注目され、電球に代えてそのまま利用できる手軽さもあり益々普及する趨勢にある。

【０００３】さらに最近、電極の無い無電極電球形蛍光ランプが、従来の有電極の電球形蛍光ランプに比べて寿命が数倍も長いことから経済的な光源として注目され、需要が増加する傾向にある。

【０００４】一方、住宅やホテルでは、人々は、読書をしたり、あるいは家族との団欒を楽しんだり、と色々な生活行為を行っており、これらの生活行為に合わせた快適な光環境とするため、それぞれの場にふさわしい明るさとすることが求められている。電球の場合には、市販の電球用調光器を利用することで容易に明るさを変えることができる。白熱電球の調光は、商用電源電圧をオン／オフし、そのオン期間を変えることによって明るさを変える方法、すなわち位相制御された電圧を白熱電球に入力するために電球用調光器を利用する方法が一般的である。一方、電球形蛍光ランプの場合にも、電球の場合と同様に既存の電球用調光器を利用して明るさを変えることが求められているが、蛍光ランプの発光は、放電によるものであるので、電球のように供給電力を単に調整するだけでは、実際に使用できるレベルの、調光可能な蛍光ランプを実現することは難しい（例えば、特許文献１，２，３および４参照）。

【０００５】

【特許文献１】特開平１１－１１１４８６号公報

【特許文献２】特許第２８３１０１６号公報

【特許文献３】特開平２－１９９７９６号公報

【特許文献４】特開２０００－２６８９９２号公報

【０００６】

【発明が解決しようとする課題】最近、電球の場合と同様に既存の電球用調光器を利用して明るさを変えたいというユーザーのニーズに応えて、電球用調光器に接続して調光点灯できる有電極の電球形蛍光ランプが開発された（特許文献１）。しかしながら、無電極の電球形蛍光ランプで調光可能なものは、いまだ開発されていないのが実情である。

【０００７】また、調光可能な前記有電極の蛍光ランプを調光点灯する場合、この蛍光ランプは市販の電球用調光器に接続して用いられることが多い。この場合、市販の電球用調光器としてはどの電球用調光器を用いても原理的には調光できるはずであるが、電球用調光器によってはランプが正常に調光点灯できず、チラツキを生じたり、蛍光ランプが点灯しにくいといった不具合が生じることがあることを本願発明者らは実際の試験により見つけだした。

【０００８】本発明は、上述した課題を解決するためのもので、チラツキや点灯のしにくさを防止し、安定な調光動作を実現する無電極放電ランプ点灯装置、電球形無電極蛍光ランプおよび放電ランプ点灯装置を提供することを目的とする。

【０００９】また本発明は、位相制御された電圧の導通期間の全期間を通して電気エネルギーを供給し、放電ランプを点灯するようにすることで調光範囲を従来の点灯装置に比べてより広くすることを他の目的とする。

【００１０】

【課題を解決するための手段】本発明に係る無電極放電ランプ点灯装置は、無電極放電ランプと、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、前記直流電圧を高周波電圧に変換し、当該高周波電圧によって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える無電極放電ランプ点灯装置であって、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとを、それぞれ実質的に同期させる。

【００１１】ある好適な実施形態において、前記ＤＣ／ＡＣ変換部は、前記高周波電圧を前記無電極放電ランプに印加して点灯させる点灯期間と、前記高周波電圧の発生を停止して前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動する。

【００１２】また、ある好適な実施形態において、前記ＤＣ／ＡＣ変換部は、前記無電極放電ランプが点灯する高周波電圧に前記直流電圧を変換して前記無電極放電ランプに印加する点灯期間と、前記無電極放電ランプが点灯しない高周波電圧に前記直流電圧を変換して前記無電極放電ランプに印加する消灯期間とで、前記無電極放電ランプを間欠駆動する。

【００１３】さらに、別の好適な実施形態において、前記ＤＣ／ＡＣ変換部は、少なくとも１つのスイッチング素子を有し、前記直流電圧を高周波電圧に変換して前記無電極放電ランプに印加する場合に、前記スイッチング素子のゲート・ソース間の電圧を変えることによって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプに前記点灯期間よりも少ない電流を流して消灯する消灯期間とで前記無電極放電ランプを間欠駆動する。

【００１４】また、前記調光制御部は、前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する手段としてフォトカプラを備えることが好ましい。

【００１５】本発明に係る電球形無電極蛍光ランプは、無電極蛍光ランプと、前記無電極蛍光ランプに高周波電圧を印加する点灯回路と、前記点灯回路に電気的に接続された口金とを備え、前記無電極蛍光ランプと前記点灯回路と前記口金とは一体に組み立てられており、前記点灯回路は、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、前記直流電圧を高周波電圧に変換し、当該高周波電圧によって、前記無電極放電ランプを点灯させる点灯期間と前記無電極放電ランプを消灯する消灯期間とで前記無電極放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを含んでおり、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとを、それぞれ実質的に同期させる。

【００１６】前記調光制御部は、前記調光制御部は、前記調光器によって位相制御された交流電圧を入力する調光信号入力部と、当該調光信号入力部に接続されたフォトカプラと、当該フォトカプラからの前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する調光指令信号部とを備えることが好ましい。

【００１７】本発明に係る第１の放電ランプ点灯装置は、放電ランプと、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、前記直流電圧を高周波電圧に変換して、当該高周波電圧を前記放電ランプに印加して点灯させる点灯期間と、前記高周波電圧の発生を停止して前記放電ランプを消灯する消灯期間とで前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのずれ量を一定に維持する。

【００１８】本発明に係る第２の放電ランプ点灯装置は、放電ランプと、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、前記放電ランプが点灯する高周波電圧に前記直流電圧を変換して前記放電ランプに印加する点灯期間と、前記放電ランプが点灯しない高周波電圧に前記直流電圧を変換して前記放電ランプに印加する消灯期間とで、前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのず

れ量を一定に維持する。

【００１９】本発明に係る第３の放電ランプ点灯装置は、放電ランプと、調光器によって位相制御された交流電圧を直流電圧に変換して出力するＡＣ／ＤＣ変換部と、少なくとも１つのスイッチング素子を有し、前記直流電圧を高周波電圧に変換して前記放電ランプに印加する場合に、前記スイッチング素子のゲート・ソース間の電圧を変えることによって、前記放電ランプを点灯させる点灯期間と前記放電ランプに前記点灯期間よりも少ない電流を流して消灯する消灯期間とで前記放電ランプを間欠駆動するＤＣ／ＡＣ変換部と、前記ＤＣ／ＡＣ変換部に、点灯期間と消灯期間との比を変える調光指令信号を出力する調光制御部とを備える放電ランプ点灯装置であって、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとのずれ量を一定に維持する。

【００２０】好適な実施形態において、前記調光制御部は、前記位相制御された交流電圧のターン・オンとターン・オフとを検出し、前記ターン・オンと前記ＤＣ／ＡＣ変換部の間欠駆動の点灯とのタイミングと、前記ターン・オフと前記ＤＣ／ＡＣ変換部の間欠駆動の消灯とのタイミングとの前記ずれ量を実質的にゼロに維持する。

【００２１】また、好適な実施形態において、前記調光制御部は、前記調光指令信号を前記ＤＣ／ＡＣ変換部に伝達する手段としてフォトカプラを備える。

【００２２】さらに、好適な実施形態において、前記放電ランプは、電極を有する有電極蛍光ランプである。

【００２３】

【発明の実施の形態】本発明の実施の形態について詳細説明をするに先立ち、本発明にあたって事前検討した事項について述べる。

【００２４】まず、図８に示す、特許文献１における従来の有電極の放電ランプ点灯装置について検討した。この放電ランプ点灯装置は、インバータ回路の動作周波数を変えて調光する周波数変化方式を用いており、入力される位相制御された電圧の導通角、すなわち電圧の導通期間（オン期間）に応じて蛍光ランプの明るさを変えるものである。

【００２５】図８に示した放電ランプ点灯装置は、商用電源１０１に接続された位相制御装置１０２と、高周波発生装置１０３と、蛍光ランプ１０８とを備えており、さらに位相制御電圧の導通角を検出する検知手段１０９、および、蛍光ランプの光出力を検出する光検出部１１０を備えている。また高周波発生装置１０３は、高周波阻止フィルタ１０４と、整流装置１０５と、位相制御された電圧を平滑化直流電圧に変換する平滑化直流電圧変換部１０６と、直流化変換電圧を高周波に変換するインバータ部１０７とから構成されている。インバータ部１０７は、スイッチング部１７１と、スイッチング部１０７を制御する信号を発する発振制御部１７２とから構成されている。また検知手段１０９は、検知した導通角に応じてインバータ部１０７の発振制御部の出力周波数を変化させる。出力周波数を変化させることで放電ランプからの発光出力が変化する。一方、光検出部１１０は、光検出量に応じて発振制御部１７２の出力周波数を変化させる。

【００２６】この周波数変化方式による調光方法では、インバータのスイッチング周波数（動作周波数）をかなり広く変える必要があり、スイッチング素子を駆動する駆動回路を広い周波数範囲で応答可能なものにする必要がある。さらに、インバータのスイッチング周波数を広い範囲で変化させるためにノイズ対策が複雑となり、コストが高くなることが指摘されている（特許文献２）。

【００２７】また別の調光方法として、電源からの交流電力をトライアックで位相制御し、さらに全波整流した出力をインバータ回路に供給し、その高周波出力を放電ランプに供給することでランプ電流を制限し調光する位相制御方式がある。しかし、この位相制御方式では、トライアックの導通角をπに近づけて調光を深くしていくと放電ランプの立ち消えやチラツキ等の現象が生ずる。このような位相制御方式を電球用調光器を通した電気入力に接続する放電ランプ点灯装置に用いると、放電ランプの立ち消えやチラツキが一層発生しやすくなる。

【００２８】この位相制御方式において調光を深くしたときに生ずる立ち消えやチラツキ現象を解消する調光方式として、インバータ回路のスイッチング周波数を一定にしておき、スイッチング素子のオン時間と、オフ時間との比率を変え、放電ランプに高電圧を間欠的に印加することにより調光する間欠駆動方式があり、たとえば、特許文献３、特許文献４で開示されている。

【００２９】しかしながら、この間欠駆動方式を用いても、電球用調光器によってはランプがちらついたり点灯しにくいといった不具合が生じることがある。本願発明者らは、この不具合の原因は、主として調光指令信号が、電球用調光器のトライアックにより位相制御された電圧のターン・オンと、ターン・オフとに同期していないことにより、放電ランプの点灯に必要なエネルギーが供給されないためと考えた。ここで、同期とは、調光指令信号とターン・オン／ターン・オフとが時間的に一致していること、あるいは常に一定のずれ時間で生じていることである。特に、無電極蛍光ランプにあっては、この無電極蛍光ランプに供給する電気エネルギーをインバータ回路のスイッチング素子をオン、オフして間欠駆動する場合、スイッチング素子をオンして無電極蛍光ランプを始動させるとき、瞬時的に大きな電気エネルギーの供給を必要とするが、調光指令信号が位相制御された電圧のターン・オン／ターン・オフに同期していないと、

ランプの始動毎に電圧の大きさが変わるので、ランプがちらついてしまうと考えた。このため無電極蛍光ランプにおいては、トライアックで位相制御された電圧のターン・オンのタイミングを、正確に検知手段により検知し、これに基づいて発生した調光指令信号によってインバータ回路のスイッチング素子を位相制御された電圧のターン・オンのタイミングに同期してオンさせることを思いついた。

【００３０】以上の検討より、本発明者らは、位相制御電圧のターン・オン／ターン・オフのタイミングと、調光指令信号のターン・オン／ターン・オフのタイミングとを実質的に同期させる調光制御部を構成することにより、チラツキを生じず、安定な調光動作をする放電ランプ点灯装置を実現した。

【００３１】以下、図面を参照しながら、本発明による実施の形態を説明する。以下の図面においては、簡素化のため、実質的に同一の機能を有する構成要素を同一の参照符号で示す。なお、本発明は、以下の実施の形態に限定されない。

【００３２】（実施の形態１）図１は、本発明による実施の形態１にかかる放電ランプ点灯装置の構成を模式的に示している。

【００３３】本実施の形態１の放電ランプ点灯装置は、無電極蛍光ランプ３と、商用電源１の電圧を位相制御する調光器２と、前記調光器２で位相制御された電圧のターン・オンおよびターン・オフに応じて無電極蛍光ランプ３を点灯制御する点灯回路４とで構成されている。商用電源１は、例えば６０Ｈｚ、１００Ｖの交流電源であり、調光器２に接続されている。調光器２は、トライアックを用いた周知の位相制御を利用した調光器で、市販の白熱電球用調光器を用いることができる。

【００３４】点灯回路４は、ＡＣ／ＤＣ変換部５と、ＤＣ／ＡＣ変換部６と、調光制御部７とで構成されている。なお、ここで言うＡＣ／ＤＣ変換部５、ＤＣ／ＡＣ変換部および調光制御部７なる用語の概念は、それぞれ、特許文献１において、平滑化直流電圧変換部、インバータ部および検知手段という用語で表現されているものに相当する。

【００３５】ＡＣ／ＤＣ変換部５は、調光器２から供給される位相制御された電圧を直流に変換する。このＡＣ／ＤＣ変換部としては、周知のものを利用すれば良く、例えばダイオード・ブリッジと平滑用コンデンサなど、を利用したものを用いることができる。

【００３６】またＤＣ／ＡＣ変換部６は、発振部２４、スイッチ回路２５、駆動回路１１、ＭＯＳＦＥＴ１２，１３、共振用インダクタ１４、共振用コンデンサ１７，１８とで構成されている。共振用コンデンサ１８に、誘導コイル１９が直列に接続され、さらに誘導コイル１９と共振用コンデンサ１８との直列回路は、共振用コンデンサ１７に並列接続されている。誘導コイル１９と無電極放電バルブ２０とで無電極蛍光ランプ３を構成している。

【００３７】また調光制御部７は、調光器２により位相制御された電圧を入力する調光制御信号入力部８と、フォトカプラ９と、調光指令信号をＤＣ／ＡＣ変換部６に伝達する調光指令信号部１０とで構成されている。

【００３８】本発明においてフォトカプラ９を用いた理由は、調光器２で位相制御された電圧の変化に応じて、調光指令信号を、スイッチ回路２５を介して、パワー回路、すなわちＤＣ／ＡＣ変換回路の影響を受けること無く、スイッチング素子１２，１３を駆動する駆動回路１１にタイミング良く確実に伝達するためである。なお当然のことながら、このためのフォトカプラ９としては、立ち上がり時間、立ち下がり時間の早い高速応答のフォトカプラを用いている。

【００３９】以下、本実施の形態１の動作について簡単に説明する。

【００４０】商用電源１の出力電圧は調光器２で位相制御され、調光器２で位相制御された交流電圧は、ＡＣ／ＤＣ変換部５で直流電圧に変換される。

【００４１】ＡＣ／ＤＣ変換部５によって平滑化された直流電圧は、ＤＣ／ＡＣ変換部６のＭＯＳＦＥＴ１２，１３の駆動回路１１が、発振部２４の駆動周波数ｆ１（Ｈｚ）、の出力で駆動され、ＭＯＳＦＥＴ１２と１３が交互にオン、オフすることにより高周波電圧に変換される。この高周波電圧が、共振用インダクタ１４、共振用コンデンサ１７，１８、誘導コイル１９からなる共振回路に印加される。ここで、無電極蛍光ランプ３は、誘導コイル１９と無電極放電バルブ２０とで構成されているので、点灯回路４は、無電極蛍光ランプ３に高周波電圧を印加するということができる。誘導コイル１９を流れる電流によって無電極放電バルブ２０内に発生される交流電磁界によって供給されるエネルギーにより、無電極放電バルブ内に封入されている発光ガス（図示せず）が励起され発光する。発光ガスとしては、例えば、水銀、クリプトン、キセノンなど、あるいはこれらの混合ガスが用いられる。

【００４２】なお、この場合、調光器２で位相制御された電圧のターン・オンとターン・オフのタイミングが調光制御部７で検出され、このターン・オンとターン・オフとの間の期間（すなわち位相制御された電圧の導通期間）、調光制御部７で発生された調光指令信号が、スイッチ回路２５に伝達され続ける。調光指令信号がスイッチ回路２５に伝達されている期間（オン期間、または無電極蛍光ランプの点灯期間）は、スイッチ回路がオンとなり、ＭＯＳＦＥＴ１２，１３の駆動回路１１をオンさせ、これに対して調光指令信号がスイッチ回路２５に伝達されていない期間（オフ期間、または無電極蛍光ランプの消灯期間）は、スイッチ回路が２５オフとなり、ＭＯＳＦＥＴ１２，１３の駆動回路１１がオフとなる。ス

イッチ回路がオンの期間中、ＭＯＳＦＥＴ１２，１３は、駆動周波数ｆ１（Ｈｚ）で、交互に、オン・オフを繰り返す。調光器２により位相制御された電圧の導通期間が変わることに応じて、調光制御部７からの調光指令信号によって決まるスイッチ回路のオン期間とオフ期間の比が変わり、これに応じてＭＯＳＦＥＴ１２，１３のオン期間とオフ期間の比（デューティ比と呼ぶ）が変わる。このデューティー比を変えることで無電極蛍光ランプ３への電気エネルギー入力が変わり、無電極蛍光ランプ３の調光が行われる。

【００４３】調光制御部７の動作について今少し詳しく説明する。

【００４４】以下、図１及び図２を参照しながら動作を説明する。図２のａからｄまでの波形を示す４つの図において、横軸は時間軸であり、各図において共通尺度である。

【００４５】図２のａは、調光器２で位相制御された電圧の波形を示しており、この位相制御された電圧は、先ず調光制御部７の調光制御信号入力部８に入力され、この調光制御信号入力部８で全波整流され、さらにフォトカプラ９を駆動するのに適当な電圧（例えば２Ｖ）に減圧してフォトカプラ９に印加される。調光器２で位相制御された電圧が、ターン・オンすると同時に、フォトカプラ９に入力される全波整流された電圧がターン・オンし、さらにフォトカプラ９の立ち上がり時間（例えば２０μｓ）後にフォトカプラ９に内蔵された発光ダイオードが発光する。このダイオードの発光によりフォトカプラ９を構成するトランジスタから、調光指令信号部１０を介して調光指令信号がスイッチ回路２５に伝達され、これによってＤＣ／ＡＣ変換部６のＭＯＳＦＥＴ１２，１３が駆動周波数ｆ１（Ｈｚ）で駆動される。この調光指令信号のオン状態は、調光器で位相制御された電圧がターン・オフされ、これによりフォトカプラ９の発光が立ち下がり、調光指令信号がオフ状態となる時間まで持続される。調光器で位相制御された電圧が再びターン・オンされると、フォトカプラ９を介して調光指令信号がオンされ、さらに位相制御された電圧がターン・オフされると、フォトカプラ９を介してスイッチ回路２５に伝達される調光指令信号がオフされ、ＤＣ／ＡＣ変換部６のＭＯＳＦＥＴ１２，１３の駆動が停止する。

【００４６】このようにして調光指令信号のオン、オフが繰り返される状態を示す波形が、図２のｂに示されている。この調光指令信号の波形（図２のｂ）とＭＯＳＦＥＴ１２，１３の駆動との関係が分かるように、一例としてＭＯＳＦＥＴ１２を取りあげ、このＭＯＳＦＥＴ１２のドレイン電流の波形を、調光指令信号の波形（図２のｂ）と時間軸を共通にして、図２のｃに示した。ＭＯＳＦＥＴ１３のドレイン電流も、ＭＯＳＦＥＴ１２に関して図２のｃに示したものと同様である。また、図２のｄに、無電極放電ランプからの発光波形を示した。図２に示したように、フォトカプラ９を利用した調光制御部７を設けることにより、調光器２により位相制御された電圧のターン・オンおよびターン・オフに正確に同期してＭＯＳＦＥＴ１２、１３の駆動が、オン、オフされ、これに呼応した無電極蛍光ランプ３からの発光出力が得られることが実験的に確認された。なお、ここでの同期とは、フォトカプラ９の立ち上がり時間、立ち下がり時間等による短時間の遅れを含んだ実質的な同期のことである。このような短時間の遅れは、入力交流電圧の周期に比べて短いので、発光出力には影響はない。

【００４７】なお、本実施の形態１の無電極蛍光ランプにおけるＤＣ／ＡＣ変換部６では、スイッチング素子としてＭＯＳＦＥＴを用いたが、パワートランジスタを用いたものであっても勿論良い。

【００４８】ここで、本実施の形態の電球形無電極蛍光ランプにおいて点灯回路４が無電極蛍光ランプ３に印加する高周波電圧の周波数について簡単に説明する。本実施の形態における当該周波数は、実用的に一般的に使用されているＩＳＭ帯の１３．５６ＭＨｚまたは数ＭＨｚと比べると、１ＭＨｚ以下（例えば、５０～５００ｋＨｚ）の比較的低い周波数の領域となっている。この低周波数領域の周波数を使用する理由を述べると、次の通りである。まず、１３．５６ＭＨｚまたは数ＭＨｚのような比較的高い周波数領域で動作させる場合、点灯回路（回路基板）内の高周波電源回路から発生するラインノイズを抑制するためのノイズフィルタが大型となり、高周波電源回路の体積が大きくなってしまう。また、ランプから放射または伝播されるノイズが高周波ノイズの場合、高周波ノイズには非常に厳しい規制が法令にて設けられているため、その規制をクリアーするには、高価なシールドを設けて使用する必要があり、コストダウンを図る上で大きな障害となる。一方、５０ｋＨｚ～１ＭＨｚ程度の周波数領域で動作させる場合には、高周波電源回路を構成する部材として、一般電子機器用の電子部品として使用されている安価な汎用品を使用することができるとともに、寸法の小さい部材を使用することが可能となるため、コストダウンおよび小型化を図ることができ、利点が大きい。ただし、本実施の形態の無電極蛍光ランプは、１ＭＨｚ以下の動作に限らず、１３．５６ＭＨｚまたは数ＭＨｚ等の周波数の領域においても動作させ得るものである。

【００４９】以上述べたように実施の形態１の放電ランプ点灯装置を用いることにより、調光器２で位相制御された電圧のターン・オン及びターン・オフに同期させて、ＤＣ／ＡＣ変換部６を間欠駆動させることにより、調光用の無電極蛍光ランプを安定して調光点灯することができ、解決すべき課題の項で述べたような不安定な点灯によるチラツキや不点灯といった不具合が生ずることはない。

【００５０】また、以上述べた本発明になる実施の形態

１で述べた放電ランプ点灯装置は、安定した調光ということだけでなく、位相制御された電圧のオン期間（導通期間）に入力される電力を、この期間全体に渡って有効に、最大限利用できる点灯装置である。換言すれば、位相制御された電圧と必ずしも同期していないことにより、放電ランプへの電力供給期間が、位相制御された電圧の導通期間よりも少なくなる従来の調光用点灯装置に比べて調光範囲が広い点灯装置である。

【００５１】（実施の形態２）本発明の実施の形態２に係る放電ランプ点灯装置は、実施の形態１の構成と類似しており、実施の形態１とは調光制御部７が異なっている。

【００５２】本実施の形態が実施の形態１と異なっている点は、フォトカプラ９に実施の形態１のフォトカプラ９よりも立ち上がり及び立ち下がり時間の長いものを用いている点である。従って、本実施の形態の放電ランプ点灯装置は、位相制御された電圧のターン・オン、ターン・オフに常に一定のずれ時間をもってＤＣ／ＡＣ変換部６を同期させて間欠駆動させる。一定のずれ時間は、フォトカプラ９の応答時間であって、例えば入力交流電圧の周期の数％よりも長い時間である。

【００５３】次に、図１０をもとに本実施の形態の放電ランプ点灯装置の動作と特性について説明する。

【００５４】図１０ａからｄまでの波形を示す図において、横軸は時間軸であり、各図において共通尺度である。図１０のａは、調光器２で位相制御された電圧の波形を示している。この図から調光器２のトライアックの導通角はπに近づいており、かなり深い調光が行われている状態であることが分かる。

【００５５】図１０のｂは、図１０のａのような位相制御された電圧が点灯回路４に入力されたとき、調光制御部７からＤＣ／ＡＣ変換部６に送られる調光指令信号を示している。図１０のａとｂとを比較すると分かるように、位相制御電圧がターン・オンした後、調光制御部７からの調光指令信号は時間Δｔだけ遅れてＤＣ／ＡＣ変換部６に送られている。

【００５６】これに伴いＤＣ／ＡＣ変換部６のスイッチング素子であるＭＯＳＦＥＴ１２のドレイン電流は、図１０のｃに示す通りになる。ＭＯＳＦＥＴ１３のドレイン電流も、図１０のｃで示されるものとほぼ同一であるため図示していない。

【００５７】ＭＯＳＦＥＴ１２，１３のドレイン電流が流れているときには、無電極蛍光ランプ３が発光し、その発光出力は図１０のｄに示す通りである。ずれ時間Δｔは一定であるので、発光出力も常に一定になり、無電極蛍光ランプ３がちらつくことはない。

【００５８】ただし、ＭＯＳＦＥＴ１２，１３のドレイン電流は、無電極蛍光ランプ３が始動するために大きなエネルギーを必要とし、図１０のｃに示すように点灯する瞬間大きな電流が流れる。調光指令信号のターン・オンが、位相制御電圧のターン・オンからΔｔ時間だけ遅れることにより、ＭＯＳＦＥＴ１２，１３のドレイン電流の立ち上がりが遅れ、その分だけ無電極蛍光ランプ３に供給される高周波電力の供給時間が減少し発光時間が短くなるだけでなく、位相制御電圧がターン・オンした直後の位相制御電圧がもっとも高い状態でＤＣ／ＡＣ変換部６の駆動が停止しているため、ずれ時間Δｔが実質的にゼロの場合に比べ、無電極蛍光ランプ３の発光出力が低下する。

【００５９】本実施の形態では、位相制御された交流電圧のターン・オン、ターン・オフと、ＤＣ／ＡＣ変換部６の間欠駆動の点灯、消灯のタイミングとのずれ量（時間Δｔ）を一定に維持しているので、放電ランプのちらつきを防止できる。このタイミングのずれは、本実施の形態ではフォトカプラ９の応答時間を利用しているが、遅延回路などを用いてずれ時間を設けても構わない。また、ずれ時間Δｔが交流電圧の一周期よりも少し短い時間の場合は、ＤＣ／ＡＣ変換部６の間欠駆動の点灯、消灯のタイミングは、位相制御された交流電圧のターン・オン、ターン・オフよりも前にずれているように観察されるが、この場合も放電ランプのちらつきは防止される。なお、発光出力の低下を考慮すると、ずれ量は小さい方が好ましく、実質的にゼロであることがより好ましい。

【００６０】（実施の形態３）本発明に係る実施の形態３における放電ランプ点灯装置は、無電極蛍光ランプを調光点灯する放電ランプ点灯装置であり、先に実施の形態１の説明で述べた構成と類似しているが、ＤＣ／ＡＣ変換部６の構成において異なっている。

【００６１】図３は、本発明の実施の形態３における放電ランプ点灯装置の点灯回路を模式的に示したものである。実施の形態１と同一の構成は、同一の符号を付して重複した説明を省略する。

【００６２】図３において、ＤＣ／ＡＣ変換部６は、発振部２４４、スイッチ回路２５５、駆動回路１１、ＭＯＳＦＥＴ１２，１３，共振用インダクタ１４，共振用コンデンサ１７，１８とで構成されている。なお発振部２４４は、発振周波数がｆ１（Ｈｚ）の発振部Ａと、発振周波数がｆ２（Ｈｚ）の発振部Ｂとで構成されており、周波数ｆ２は、周波数ｆ１よりも低い周波数に設定されている。駆動回路１１は、調光指令信号部１０から調光指令信号がスイッチ回路２５５に出力されるときには発振部Ａと接続され、また駆動回路１１は、調光指令信号部１０から調光指令信号が駆動回路２５５に出力されないときには発振部Ｂと接続される構成となっている。

【００６３】以下本実施の形態３の動作について簡単に説明する。

【００６４】本実施の形態３においても放電ランプの点灯原理は、実施の形態１の場合と同じであり重複して説明しない。

【００６５】調光器２から調光制御部７に入力される位相制御された電圧に対する調光制御部７の動作も実施の形態１の場合と基本的に同じであり詳しい説明を省略する。

【００６６】調光制御信号入力部８に入力された位相制御された電圧から、先に実施の形態１で述べたようにフォトカプラ９を利用する方法で、２値化した、オン、オフの調光指令信号出力を得ることができる。

【００６７】フォトカプラ９に内蔵されたトランジスタを介して調光指令信号がスイッチ回路２５５に伝達される、調光指令信号がオンのとき、スイッチ回路において、発振周波数がｆ１（Ｈｚ）である発振部Ａと駆動回路１１とが接続され、スイッチング素子たるＭＯＳＦＥＴ１２，１３は、スイッチング周波数ｆ１（Ｈｚ）で、交互に、駆動する。これにより高周波電圧が発生し、無電極蛍光ランプ３を点灯する。

【００６８】一方、フォトカプラ９に内蔵されたトランジスタを介して調光指令信号がスイッチ回路２５５に伝達されない、調光指令信号がオフのときには、スイッチ回路２５５において、発振周波数がｆ２（Ｈｚ）である発振部Ｂと駆動回路１１とが接続され、スイッチング素子たるＭＯＳＦＥＴ１２と１３は、スイッチング周波数ｆ２（Ｈｚ）で、交互に、駆動する。ただし、この場合、発振部Ｂの周波数ｆ２（Ｈｚ）は、発振部Ａの周波数ｆ１（Ｈｚ）に比べて低く設定されているため、無電極蛍光ランプ３の誘導コイル１９を流れる高周波電流は、調光指令信号がオンの場合に比べて少ない。このように発振部２４４の発振周波数の設定にあたっては、周波数がｆ２（Ｈｚ）のとき誘導コイル１９を通して電流は流れるが、無電極蛍光ランプ３は点灯しないように設定してある。ｆ２（Ｈｚ）の周波数では、放電バルブ２０の内部で放電が生じない、あるいは発光には不十分な放電しか生じないからである。つまり、ｆ１（Ｈｚ）の電圧が、無電極蛍光ランプ３が点灯する高周波電圧であり、ｆ２（Ｈｚ）の電圧が、無電極蛍光ランプ３が点灯しない高周波電圧である。

【００６９】実施の形態３の動作の理解を助けるために、位相制御された電圧の電圧波形、調光指令信号の波形、ＭＯＳＦＥＴ１２のドレイン電流の波形、および無電極蛍光ランプ３からの発光出力の波形を、図４のａ、ｂ、ｃ及びｄに、それぞれ示した。

【００７０】図２のｃと図４のｃとを比較すると、本実施の形態３のように無電極蛍光ランプ３の消灯時間に、点灯しない程度の電流を流しておいた場合（図４のｃ）、位相制御された電圧がターン・オンされたときの無電極放電ランプからの発光出力は、実施の形態１で述べた消灯時間に電流を流さない場合（図２のｃ）に比べてより少ない電流で立ち上がっていることが分かる。これは、消灯時間においても無電極放電バルブ２０において電離した発光ガスが存在しているため、次回に無電極放電バルブ２０を点灯させるためのエネルギーが少なくなるためのである。点灯させるためのエネルギーが少なくなると、点灯が容易となり、その結果光束立ち上がりも早くなる（図４のｄの発光出力の立ち上がりが、図２のｄと比べて急峻になる）。

【００７１】以上述べた本実施の形態３の構成とすることにより、無電極蛍光ランプ３の調光を深くして、ＤＣ／ＡＣ変換部６のＭＯＳＦＥＴ１２，１３が駆動するオン期間が短かく、すなわちデューティー比を小さくしても、位相制御された電圧に同期した確実に調光点灯が可能である。

【００７２】なお、本実施の形態では、発振部Ｂの周波数ｆ２（Ｈｚ）が、発振部Ａの周波数ｆ１（Ｈｚ）より低く設定したが、これと逆に、発振部Ｂの周波数ｆ２（Ｈｚ）が、発振部Ａの周波数ｆ１（Ｈｚ）より高く設定したものであっても良い。

【００７３】また、上記実施の形態３では、点灯期間と、消灯期間とで、駆動周波数をｆ１と、ｆ２とに、それぞれ、変えることによって、消灯期間に無電極放電バルブ２０を流れる高周波電流が点灯期間に流れる高周波電流よりも少なくした。これと同様に、点灯期間と消灯期間とで、ＭＯＳＦＥＴ１２，１３のゲート・ソース間の電圧を変えることよって、ドレイン電流を制御し、消灯期間に放電バルブ２０を流れる高周波電流が、点灯期間に流れる高周波電流よりも少なくなるようにしても実施の形態３と同様な効果を得ることができる。

【００７４】（実施の形態４）実施の形態４は、本発明の他の応用例に係る無電極放電ランプ点灯装置である。なお、実施の形態１，３と同一の構成は、同一の符号を付して説明を省略する。

【００７５】図５は、本発明の実施の形態４における無電極放電ランプ点灯装置の回路図である。

【００７６】本無電極放電ランプ点灯装置は、無電極蛍光ランプ３と、入力電圧を位相制御する調光器２と、前記調光器２によって位相制御された電圧のターン・オンとターン・オフとの期間、すなわち導通期間に同期して、前記無電極蛍光ランプ３を点灯制御する点灯回路４とから構成されている。

【００７７】以下、本実施の形態４の無電極放電ランプ点灯装置の構成と動作について説明する。

【００７８】点灯回路４は、ＡＣ／ＤＣ変換部５と、ＤＣ／ＡＣ変換部６と、調光制御部７とで構成されている。

【００７９】ＡＣ／ＤＣ変換部５は、ダイオードブリッジＤＢ１と電解コンデンサＣ２とで構成されている。このＡＣ／ＤＣ変換部５に、突入電流防止用の抵抗や雑音防止フィルタが接続されていても勿論よい。

【００８０】電源が入力されると、調光器２で位相制御された電圧は、ＡＣ／ＤＣ変換部５のダイオードブリッジＤＢ１で整流され、さらに電解コンデンサＣ２で平滑

化され、この出力がＤＣ／ＡＣ変換部６に送られる。
【００８１】次に、ＤＣ／ＡＣ変換部６の構成と動作を説明するにあたっては、先ず、調光制御部７から調光指令信号がＤＣ／ＡＣ変換部６に送られず、すなわちトランジスタＱ４がオフであり、ＤＣ／ＡＣ変換部６のスイッチング素子であるＭＯＳＦＥＴ１２，１３が、駆動している状態を考え、この状態について説明する。
【００８２】商用電源１から調光器２に入力され，位相制御された電圧はＡＣ／ＤＣ変換部５で整流され、平滑コンデンサＣ２，ＤＣ／ＡＣ変換部６のＭＯＳＦＥＴ１３のトリガコンデンサＣ４及びチャージポンプ回路機能を果たすコンデンサＣ８を充電する。
【００８３】トリガコンデンサＣ４の充電電圧がチェナーダイオードＺＤ４のチェナー電圧に達すると、抵抗Ｒ２，Ｒ４，Ｒ３を通して電流が流れ、ＭＯＳＦＥＴ１３のゲート・ソース間にゲート電圧が供給されてえ、ＭＯＳＦＥＴ１３がオン状態になる。
【００８４】ＭＯＳＦＥＴ１３がオン状態になった当初は、平滑コンデンサＣ２の電圧が電源電圧より低いため、電源１から調光器２、さらにＡＣ／ＤＣ変換部５を介して、共振コンデンサ１８，１７、インダクタＬ１、誘導コイル１９，トランスＣＴの一次巻線ＣＴ１、ＭＯＳＦＥＴ１３を通して電流が流れる。
【００８５】一方、トランスＣＴの一次巻線ＣＴ1を流れる電流によって、トランスＣＴの二次巻線ＣＴ３に誘導電圧が発生し、ＭＯＳＦＥＴ１３にゲート電圧を供給することができるため、ＭＯＳＦＥＴ１３はオン状態を続ける。
【００８６】しかし、トランスＣＴの各巻線を流れる電流が増加すると、一定時間経過後、トランスＣＴのコア自体が磁気飽和し、トランスＣＴの二次巻線ＣＴ３の誘導電圧が生じなくなり、ＭＯＳＦＥＴ１３のゲート電圧が供給できなくなり、ＭＯＳＦＥＴ１３はオフとなる。
【００８７】なお、トランスＣＴの二次巻線ＣＴ２に接続されるＭＯＳＦＥＴ１３と、トランスＣＴの二次巻線ＣＴ３に接続されるＭＯＳＦＥＴ１２のゲート・ソース間に流れる電流の方向が異なるため、ＭＯＳＦＥＴ１３がオフ状態になると、ＭＯＳＦＥＴ１２のゲート電圧が上昇する。したがって、かかる電圧上昇によってＭＯＳＦＥＴ１２は、オン状態となる。
【００８８】ＭＯＳＦＥＴ１２がオン状態になると、電流は、ＭＯＳＦＥＴ１２、トランスＣＴ、インダクタＬ１、コンデンサＣ１７，コンデンサＣ１７に並列に接続された、コンデンサ１８と誘導コイル１９の直列回路を通して流れる。この電流は、インダクタＬ１、共振コンデンサＣ１８，Ｃ１７及び誘導コイル１９とで共振する。
【００８９】さらに、電流トランスＣＴの各巻線を流れる電流が増加すると、再度、電流トランスＣＴのコア自体が磁気飽和する。電流トランスＣＴのコアが磁気飽和すると、二次巻線ＣＴ２の出力が無くなり、ＭＯＳＦＥＴ１２にゲート電圧を供給できなくなる。こうしてＭＯＳＦＥＴ１２はオフ状態となる。
【００９０】以後、上述した動作を繰り返すことで、ＭＯＳＦＥＴ１２とＭＯＳＦＥＴ１３において、駆動周波数ｆ１（Ｈｚ）、例えば２００（ｋＨｚ）でオン状態とオフ状態とを、交互に、切り替えることができる。
【００９１】これによってＤＣ／ＡＣ変換部６の共振回路に高周波電圧を発生し、誘導コイル１９を介して無電極放電バルブ２０に電磁エネルギーを供給し、無電極放電バルブ２０の内部に封入された発光ガスを励起し紫外放射を放射させ、この紫外放射によって無電極放電バルブ２０内部に塗布した蛍光体（図示せず）を励起発光させ、無電極蛍光ランプ３を点灯することができる。
【００９２】次に、調光制御部７から調光指令信号がＤＣ／ＡＣ変換部６に伝達され、調光点灯が行われる場合の動作について説明する。
【００９３】調光器２で位相制御された電圧（図４のａ参照）を、抵抗Ｒ３０とＲ３１とでフォトカプラ９の駆動に適切な電圧となるように分圧して、ダイオード・ブリッジＤＢ２に入力し、全波整流された電圧がフォトカプラ９のフォト・ダイオードに印加されるようになっている。したがって、位相制御された電圧がターン・オンされると同時にフォトカプラ９のフォト・ダイオードに全波整流された電圧が印加され、フォト・ダイオードが発光し、これによりフォトカプラ９のフォト・トランジスタに電流が流れ、フォトカプラ９がオンとなる。
【００９４】フォトカプラ９がオンとなると、トランジスタＱ４のベース電位がゼロになり、トランジスタＱ４のコレクタ電流は流れない。このためＱ４は、ＭＯＳＦＥＴ１２およびＭＯＳＦＥＴ１３のオン、オフ駆動には何ら影響を与えず、ＭＯＳＦＥＴ１２，１３には図４のｃに示したようなドレイン電流が流れ、ＤＣ／ＡＣ変換部６には高周波電圧が発生し、無電極蛍光ランプ３が点灯する。
【００９５】調光器２により位相制御された電圧がターン・オンされてフォトトランジスタを通して流れる電流は、位相制御された電圧がターン・オフされ、フォトカプラ９のフォト・ダイオードにダイオード・ブリッジＤＢ２を介して電圧が印加されなくなるまで持続する、すなわち、無電極蛍光ランプ３の点灯が持続する。
【００９６】調光器２により位相制御された電圧がターン・オフされると、フォトカプラ９に印加される電圧はゼロであり、したがってフォトカプラ９はオフ状態となる。この状態において、トランジスタＱ４のベースには直流電源回路（例えば３端子レギュレータ）４０により抵抗Ｒ３５を介して直流電圧が印加され、Ｑ４のコレクタ電流が流れる。これにより抵抗Ｒ３と並列に抵抗Ｒ３８が入ることになり、ＭＯＳＦＥＴ１３のゲート電圧が下がり、ＭＯＳＦＥＴ１２はオフ状態となり、無電極放

電バルブ２０には高周波電圧がかからなくなり無電極蛍光ランプ３は消灯する。このＭＯＳＦＥＴ１２のオフ状態は、調光器２により位相制御された電圧が、再び、ターン・オンされるまで続く。

【００９７】このように、位相制御された電圧が、ターン・オン及びターン・オフされるのと同期してＭＯＳＦＥＴ１２，１３がオン、オフを繰り返し、さらにＭＯＳＦＥＴ１２，１３がオン、オフするのと同期して無電極蛍光ランプ３が点灯と消灯を繰り返す。なお、抵抗Ｒ３８のＤＣ／ＡＣ変換部６内部での接続部分は、二つのツェナーダイオードＺＤ３，ＺＤ４の間以外に、抵抗Ｒ６とツェナーダイオードＺＤ３との連結部分でもよい。どちらであっても無電極蛍光ランプ３がオン、オフを繰り返すからである。

【００９８】よって、本実施の形態によって先の実施の形態３で述べた効果と同様な効果が得られることは言うまでもない。

【００９９】（実施の形態５）図６は、実施の形態５に係る放電ランプ点灯装置の回路図である。先に述べた実施の形態１と異なる点は、放電バルブ２００が有電極であり、この有電極の蛍光ランプ３３を点灯するために負荷共振回路の構成が異なる点だけである。なお実施の形態１と同一の構成は、同一符号を付して説明を省略する。

【０１００】図６において、ＭＯＳＦＥＴ１３のドレイン端子とソース端子間に蛍光ランプ３３、共振用インダクタ１４，共振用コンデンサ１５，共振兼余熱用のコンデンサ１６とで構成されたＬＣ共振回路が接続されている。

【０１０１】上述したＬＣ共振回路のコンデンサ１６の両端に共振電圧として高電圧が発生する。放電バルブ２００内の２つの電極への余熱電流によって電極の温度が上昇し、電極から熱電子が発生しやすくなると、放電バルブ２００は絶縁破壊を起こし放電を開始する。放電バルブ２００が放電を始めると共振用インダクタ１４により放電バルブ２００を流れる電流を制限し安定した放電を維持する。

【０１０２】本実施の形態５の調光制御部７の構成と動作は、実施の形態１の場合と同様である。放電ランプ点灯装置の構成を図６のような構成とすることにより、調光可能な一般の有電極の蛍光ランプを安定して調光点灯できることは先の実施の形態１の説明から明らかであり、重複して説明しない。

【０１０３】（実施の形態６）次に、実施の形態６の放電ランプ点灯装置の構成を説明する。図７は、本実施の形態６として無電極の電球形蛍光ランプを取りあげ、その構成を模式的に示している。なお、本実施の形態の放電ランプ点灯装置は、無電極の電球形蛍光ランプとしたが、有電極の電球形蛍光ランプの構成とすることもできる。

【０１０４】図７に示した無電極電球形蛍光ランプは、凹入部２０ａを有し、水銀と稀ガス例えばアルゴン（図示せず）を封入した透光性の放電バルブ２０で構成された無電極蛍光ランプ３と、例えば白熱電球用Ｅ２６型などの口金５６と、点灯回路（例えば図６で示した回路）の構成の配線が形成され各々の回路部品が取り付けられた回路基板５４と、回路基板を収容するカバー５５とを有している。

【０１０５】放電バルブ２０の内部に封入した水銀励起のための放電プラズマの生成は、誘導コイル１９によって放電バルブ内に発生される交流電磁界によって供給されるエネルギーによって行われる。誘導コイル１９は、フェライト磁芯と１９ａと巻線１９ｂとで構成されており、放電バルブが有する凹入部２０ａに配置されている。

【０１０６】無電極蛍光ランプ３と、回路基板５４と口金５６は、図示していないが、それぞれ、互いに電気的に接続されており、口金５６を介して白熱電球用ソケットにねじ込むことで電力が供給されて、無電極蛍光ランプ３が点灯する。

【０１０７】口金５６を通して入力される交流電圧は、外部の位相制御装置（例えば、白熱電球用調光器等）によって位相制御された交流電圧である。

【０１０８】放電ランプは、本実施の形態のように無電極蛍光ランプでなく有電極の蛍光ランプであっても勿論良い。

【０１０９】また、本実施の形態では、無電極放電ランプ３と点灯回路と口金とが一体に組み立てられた電球形無電極蛍光ランプを示したが、本実施の形態はこれに限られず、無電極蛍光ランプ３と点灯回路とが別々になっているような放電ランプ点灯装置（無電極放電ランプ点灯装置）であってもよい。

【０１１０】（他の実施の形態）実施の形態１～６で述べた放電ランプの形状は、直管、丸管、Ｕ字管、など一般照明用に供されるものであればどんな形状のものであっても良い。

【０１１１】また、本発明の放電ランプ点灯装置は、一般照明用の蛍光ランプに限定されることなく、例えば紅斑効果やビタミンＤの生成に有効な作用スペクトルを有する健康線ランプや、植物の光合成や形態形成に有効な作用スペクトルを有する植物育成用ランプを点灯するものであっても勿論良い。

【０１１２】さらに本発明の放電ランプ点灯装置が点灯対象とする放電ランプは、殺菌ランプのように放電バルブに蛍光体を塗布しない放電ランプであってもよい。

【０１１３】なお、上記実施の形態１では、調光制御部７は、ターン・オンとＤＣ／ＡＣ変換部６の間欠駆動の点灯とのタイミングを同期させる信号を出力する構成を有しているが、これは、同期させた方が良好に調光動作を実行させることができるからである。

【０１１４】図９に示した構成は、間欠駆動の点灯回路４’でありながらターン・オンとＤＣ／ＡＣ変換部６の間欠駆動の点灯とのタイミングを同期させることを意図していないものである。上記実施の形態１の構成と異なるのは、調光制御信号を発生させ、ＤＣ／ＡＣ変換部（インバータ回路）６に調光指令信号を送る調光制御部７’の構成である。

【０１１５】調光制御部７’は、調光信号発生部７４とＤＣ／ＡＣ変換部６に調光指令信号を送る調光指令信号部１０とで構成されている。トライアックで位相制御された調光器２からの出力は、半波整流回路７１を介して半波整流され、その出力電圧（１２０Ｈｚ）と、基準周波数（１２０Ｈｚ）の基準電圧を発生する三角波発生回路７２の出力電圧とが、比較器７３で比較され、比較器７３から周波数が一定で、矩形波状の調光信号が出力される。この調光信号を調光指令信号部１０を介してＤＣ／ＡＣ変換部６に送り、ＤＣ／ＡＣ変換部６のオン時間とオフ時間とを変えて無電極蛍光ランプ３の調光を行った。放電ランプとしては無電極蛍光ランプ３を用い、インバータ回路のスイッチング周波数ｆ１は２００ｋＨｚとし、スイッチング素子としてはＭＯＳＦＥＴ１２，１３を用いた。

【０１１６】図１１に実験結果の一例を示した。

【０１１７】以下、図１１をもとに図９の放電ランプ点灯装置の動作と特性について説明する。図１１ａからｄまでの波形を示す図において、横軸は時間軸であり、各図において共通尺度である。図１１のａは、調光器２で位相制御された電圧の波形を示している。この図から調光器２のトライアックの導通角はπに近づいており、かなり深い調光が行われている状態であることが分かる。

【０１１８】図１１のｂは、図１０のａのような位相制御された電圧が点灯回路４’に入力されたとき、調光制御部７からＤＣ／ＡＣ変換部６に送られる調光指令信号を示している。図１１のａとｂとを比較すると分かるように、位相制御電圧のターン・オンと、調光指令信号のターン・オンとは同期が取れていない。つまり、調光指令信号のターン・オン／ターン・オフのタイミングが、位相制御電圧のターン・オン／ターン・オフのタイミングからずれており、しかも、そのずれる時間Δｔが時刻により変動している。

【０１１９】この調光指令信号が図１１のｂに示すように変動したとき、ＭＯＳＦＥＴ１２（または１３）のドレイン電流が図１１のｃのように変化し、その結果無電極蛍光ランプへの電気エネルギーの供給が減少し発光出力が図１１のｄのように変化し、チラツキを生ずる。

【０１２０】調光器２によりさらに深い調光をしていくと、ＭＯＳＯＳＦＥＴ１２，１３のドレイン電流が減少し、その結果、無電極蛍光ランプ３に供給される高周波電力が低減し、点灯するか消灯するかの閾状態に近い状態となる。

【０１２１】今、位相制御された電圧のターン・オンのタイミングと、調光制御部７’からの調光信号のターン・オンのタイミングとが同期している状態では、無電極蛍光ランプ３がかろうじて点灯できるような電気エネルギーを無電極蛍光ランプ３に供給できる放電ランプ点灯装置を考える。この装置において、図１１に示すように調光指令信号のターン・オンが位相制御電圧のターン・オンとのタイミングがずれ、そのずれ時間の長さが変動していくと、この点灯装置に取り付けた無電極蛍光ランプ３は上述した説明から分かるようにほとんど消灯し、たまに点灯する状態になる。また深い調光を行う場合、位相制御電圧のターン・オンと調光指令信号のターン・オンのタイミングとのずれ時間Δｔが大きくなると、無電極蛍光ランプ３がまったく点灯できない状態となる。

【０１２２】因みに、実施の形態１の放電ランプ点灯装置に図１０ａに示す深い調光の位相制御電圧と同じ電圧を印加したときの、位相制御電圧、調光指令信号、ＭＯＳＦＥＴ１２のドレイン電流及び発光出力の、各波形を図１２のａ、ｂ、ｃ及びｄに、それぞれ示した。図１１のｄと、図１２のｄとを比較して分かるように、調光器２により位相制御された電圧のターン・オンおよびターン・オフに、ＤＣ／ＡＣ変換部のスイッチング素子のターン・オン及びターン・オフのタイミングを正確に同期させた本発明になる放電ランプ点灯装置（図１）は、ちらつきが無く、且つ、発光出力も多いことを確認している。

【０１２３】

【発明の効果】以上説明したように、本発明になる放電ランプ点灯装置によれば、調光器により位相制御された電圧を無電極、あるいは、有電極の蛍光ランプに入力し、蛍光ランプを調光する場合、位相制御された電圧のターン・オンおよびターン・オフのタイミングと、ＤＣ／ＡＣ変換部を間欠駆動させるための調光指令信号のターン・オンおよびターン・オフのタイミングとを同期させることによりチラツキや、立ち消えをすることなく安定な調光動作を実現できる。

【０１２４】さらに、本発明の放電ランプ点灯装置を利用することにより、従来の点灯装置に比べて放電ランプに電気エネルギーをより多く供給でき、放電ランプ発光出力の増大が図れる。

【図面の簡単な説明】

【図１】本発明における実施の形態１の放電ランプ点灯装置の回路構成図である。

【図２】実施の形態１の放電ランプ点灯装置における回路およびランプの特性図である。

【図３】本発明のおける実施の形態３の放電ランプ点灯装置の回路構成図である。

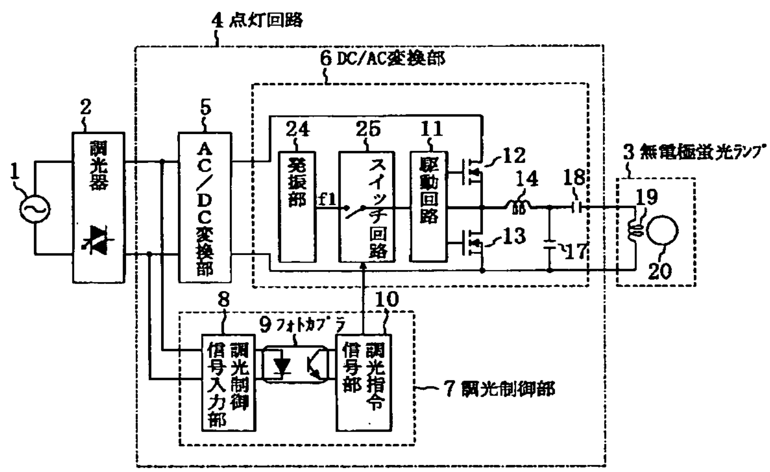
【図４】実施の形態３の放電ランプ点灯装置における回路およびランプの特性図である。

【図５】本発明における実施の形態４の放電ランプ点灯

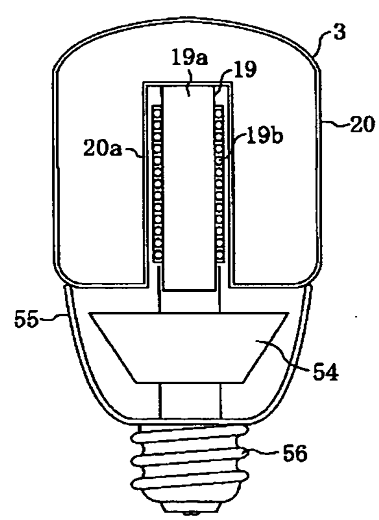
装置の回路図である。
【図6】本発明における実施の形態5の放電ランプ点灯装置の回路構成図である。
【図7】本発明における実施の形態6の放電ランプ点灯装置の模式的な断面図である。
【図8】従来例における有電極放電ランプ点灯装置の回路構成図である。
【図9】非同期タイプの放電ランプ点灯装置の回路構成図である。
【図10】実施の形態2の放電ランプ点灯装置における回路およびランプの特性図である。
【図11】図9の放電ランプ点灯装置における回路およびランプの特性図である。
【図12】実施の形態1の放電ランプ点灯装置における別の回路およびランプの特性図である。
【符号の説明】

1	電源
2	調光器
3	無電極蛍光ランプ（無電極放電ランプ、放電ランプ）
33	蛍光ランプ（放電ランプ）
4、4’	点灯回路
5	AC／DC変換部
6	DC／AC変換部
7，7’	調光制御部
9	フォトカプラ
11	駆動回路
19	誘導コイル
20	無電極放電バルブ
24，244	発振部
25，255	スイッチ回路
54	基板
55	ケース
56	口金
71	半波整流回路
72	三角波発生回路
73	比較器
74	調光信号発生部

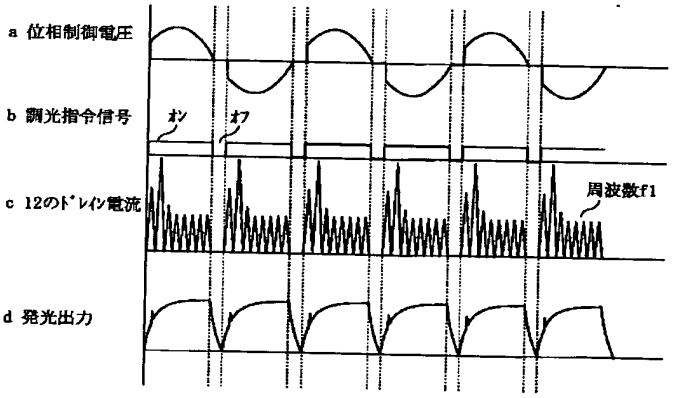
【図1】



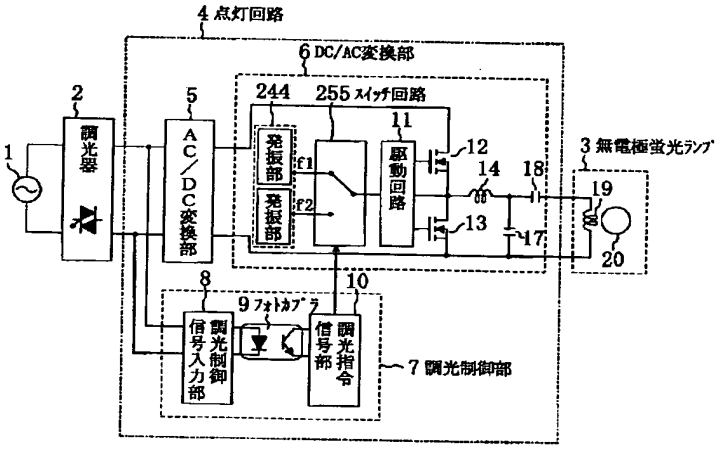
【図7】



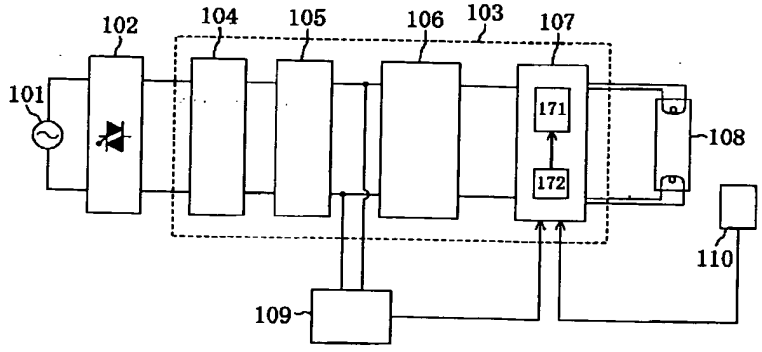
【図2】


a 位相制御電圧
b 調光指令信号
オン
オフ
c 12のドレイン電流
周波数f1
d 発光出力

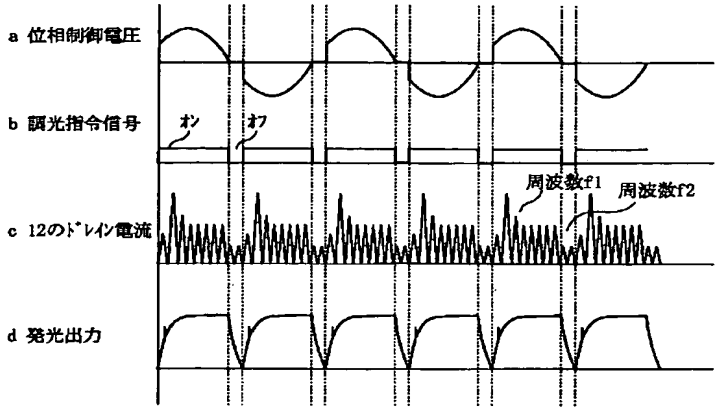
【図3】


4 点灯回路
6 DC/AC変換部
2
5
244
255 スイッチ回路
11
1
調光器
AC/DC変換部
発振部
f1
発振部
f2
駆動回路
12
13
14
18
17
3 無電極蛍光ランプ
19
20
8
9 フォトカプラ
10
調光制御信号入力部
調光指令信号部
7 調光制御部

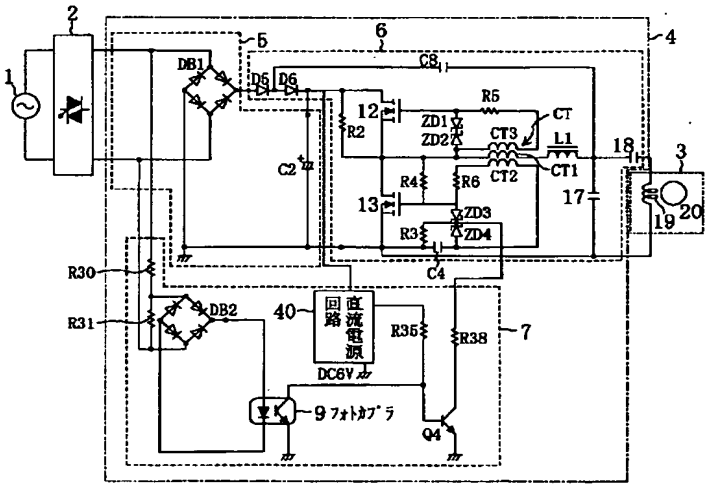
【図8】


102
104
105
106
103
107
101
171
172
108
110
109

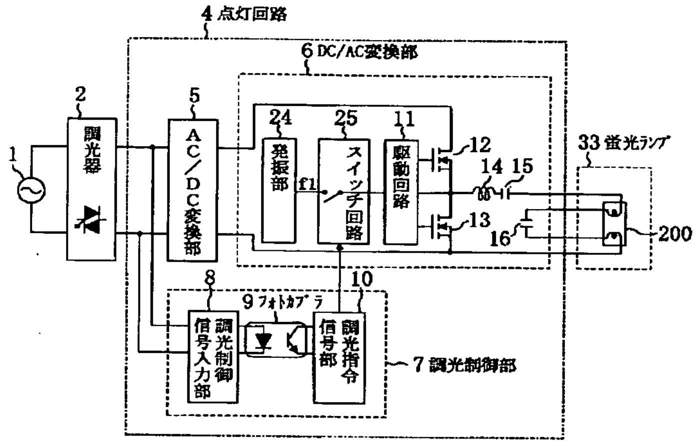
【図4】


a 位相制御電圧
b 調光指令信号
オン
オフ
c 12のドレイン電流
周波数f1
周波数f2
d 発光出力

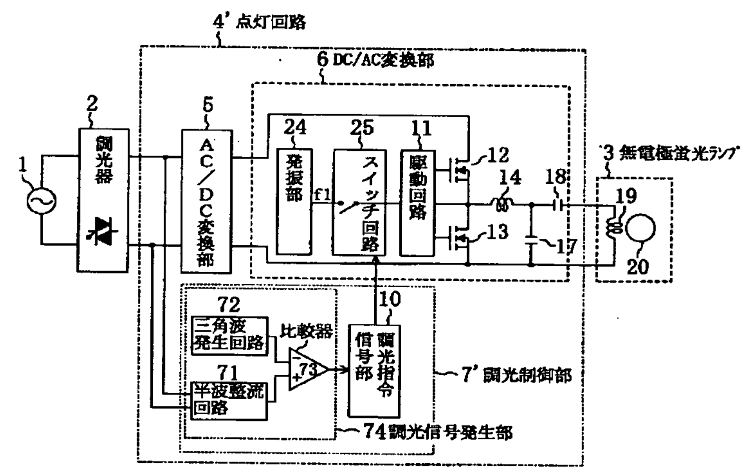
【図5】


1
2
4
5
6
7
DB1
D5
D6
C8
R5
12
R2
ZD1
ZD2
CT
CT3
L1
CT2
CT1
18
3
19
20
C2
R4
R6
13
ZD3
R3
ZD4
17
C4
R30
R31
DB2
40
回路
直流電源
R35
R38
DC6V
9 フォトカプラ
Q4

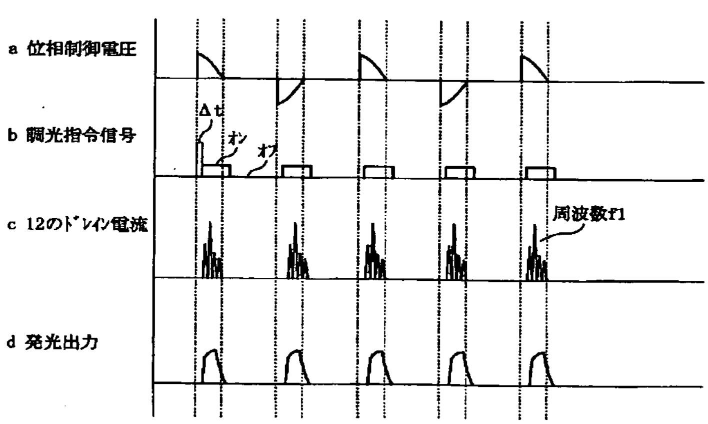
【図6】


4 点灯回路
6 DC/AC変換部
2
5
24
25
11
12
33 蛍光ランプ
調光器
A C / D C 変換部
発振部
f1
スイッチ回路
駆動回路
14 15
13
16
200
8
9 フォトカプラ
10
調光制御信号入力部
調光指令信号部
7 調光制御部
1

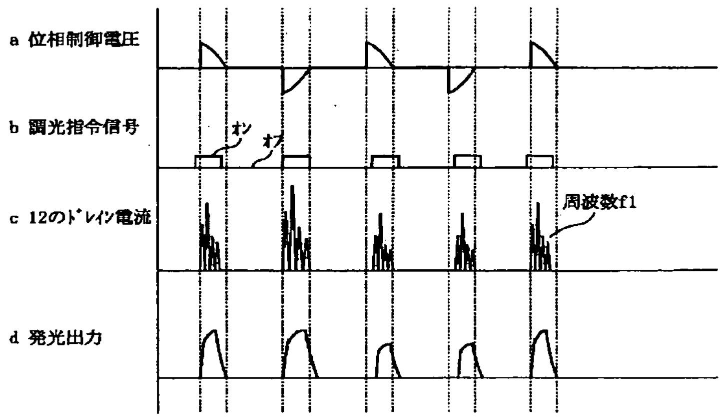
【図9】


4' 点灯回路
6 DC/AC変換部
2
5
24
25
11
12
3 無電極蛍光ランプ
1
調光器
A C / D C 変換部
発振部
f1
スイッチ回路
駆動回路
14
18
19
13
17
20
72
三角波発生回路
比較器
73
71
半波整流回路
10
調光指令信号部
7' 調光制御部
74 調光信号発生部

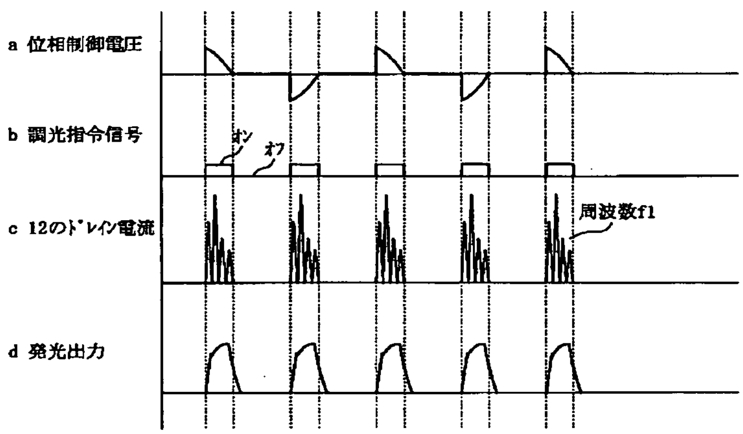
【図10】


a 位相制御電圧
b 調光指令信号
Δt
オン
オフ
c 12のドレイン電流
周波数f1
d 発光出力

【図11】



【図12】



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